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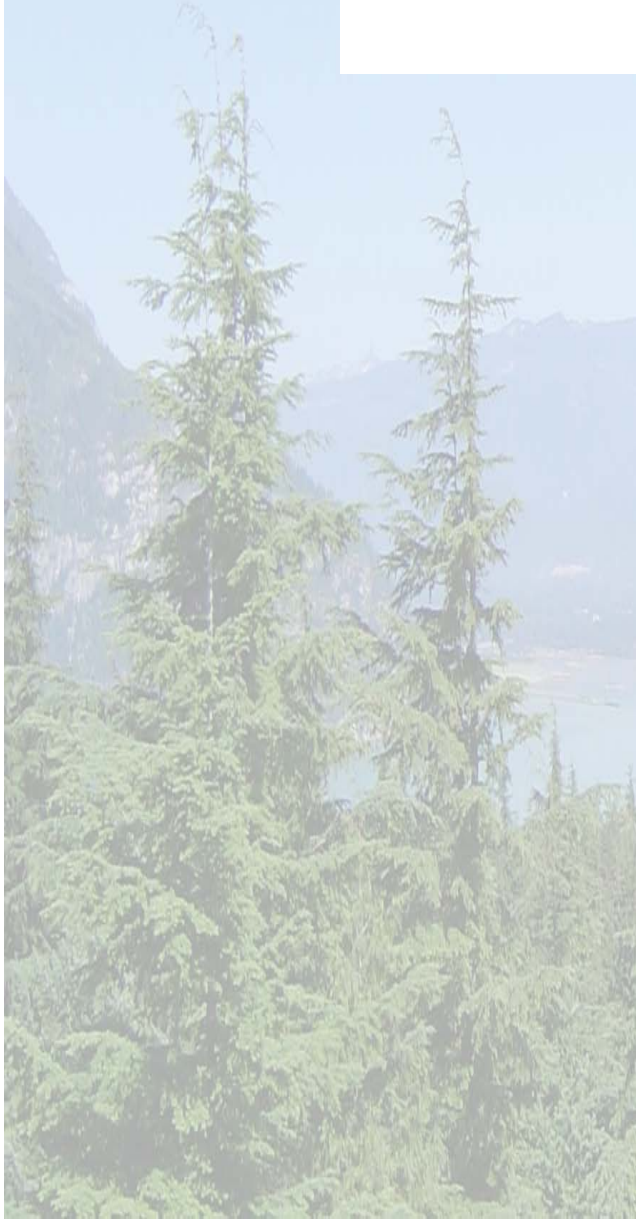
Ministry of Water, Land & Air Protection

LOWER MAINLAND REGION

Water Quality Objectives Attainment Monitoring in Burrard Inlet in 2002



ENVIRONMENTAL QUALITY

Water Quality Objectives Attainment Monitoring in Burrard Inlet in 2002

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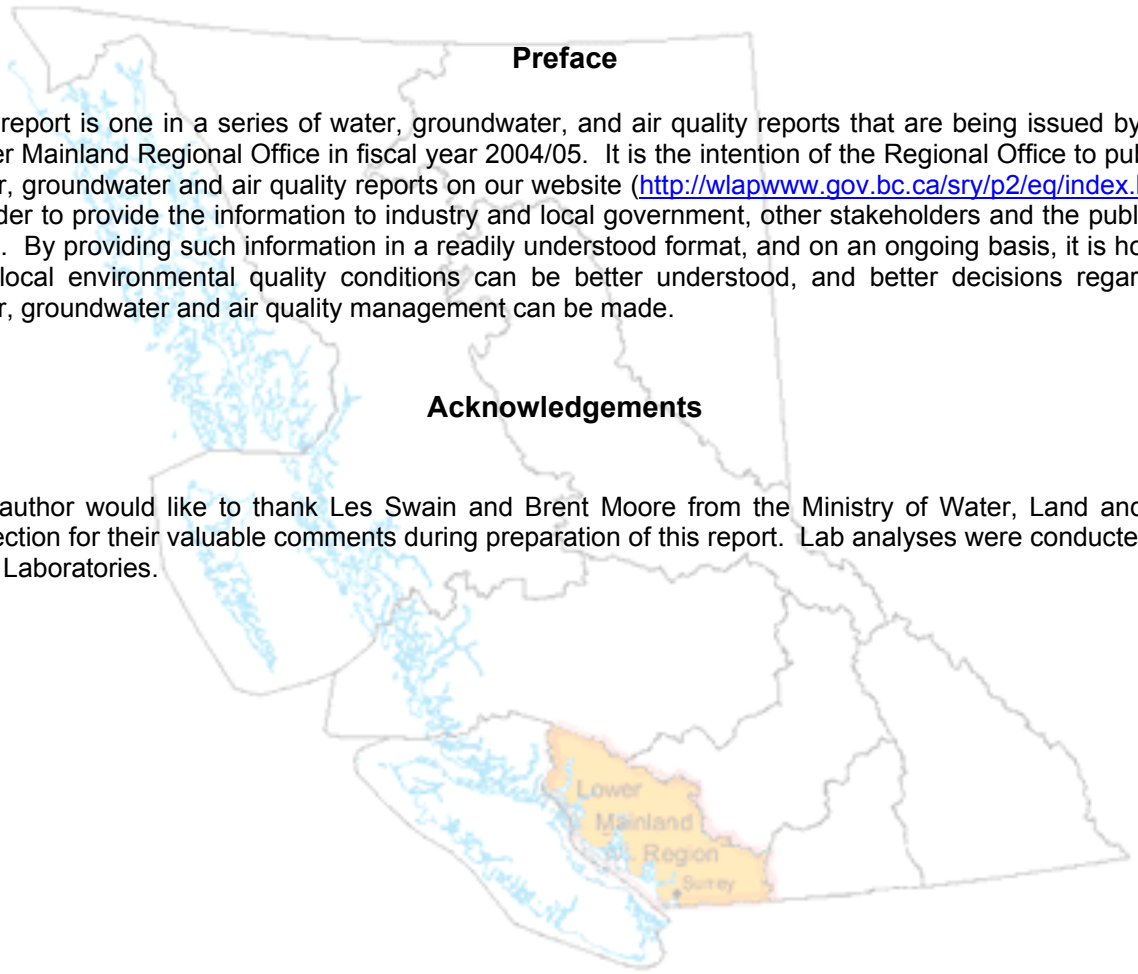
Preface

This report is one in a series of water, groundwater, and air quality reports that are being issued by the Lower Mainland Regional Office in fiscal year 2004/05. It is the intention of the Regional Office to publish water, groundwater and air quality reports on our website (http://wlapwww.gov.bc.ca/sry/p2/eq/index.htm) in order to provide the information to industry and local government, other stakeholders and the public at large. By providing such information in a readily understood format, and on an ongoing basis, it is hoped that local environmental quality conditions can be better understood, and better decisions regarding water, groundwater and air quality management can be made.

Acknowledgements

The author would like to thank Les Swain and Brent Moore from the Ministry of Water, Land and Air Protection for their valuable comments during preparation of this report. Lab analyses were conducted by PSC Laboratories.



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1.0 INTRODUCTION

In 1990, provisional water quality objectives for Burrard Inlet were set to protect aquatic life, wildlife and primary-contact recreation. These objectives were developed in response to the Greater Vancouver Regional District (GVRD) initiating the preparation of a liquid waste management plan in 1985. The provisional objectives were set to protect the most sensitive designated water use while also considering ambient water quality, aquatic life, waste discharges and socio-economic factors (Nijman and Swain 1990). As sub-basins in Burrard Inlet have different uses and sources of contamination, objectives were developed for each sub-basin (Figure 1).

Research and literature reviews conducted for the objectives development found that pollution had impacted water, sediment and biota in Burrard Inlet (Nijman and Swain 1990). Since 1990, monitoring programs and special studies of Burrard Inlet have been conducted by various agencies, institutions and industries. Burrard Inlet has been the subject of these multiple efforts due to both the concentration of municipal and industrial activities bordering the inlet, as well as the large urban population within the watershed.

Prior to 2002, comprehensive water and sediment monitoring to assess attainment of the Burrard Inlet objectives were last conducted by the Ministry of Water, Land and Air Protection (MWLAP) between 1993 and 1994. Following 1994, periods of financial constraint restricted sampling efforts. Sampling in 1995 only examined fecal coliforms at bathing beaches while monitoring conducted in 2000 involved the collection of limited water samples as well as core and grab sediment samples. The 2002 attainment monitoring program was designed to provide more comprehensive information regarding the current environmental conditions in Burrard Inlet, both near discharges as well as at ambient sites. Fish tissue, which the MWLAP has not collected in Burrard Inlet since 1992, was also sampled in the 2002/2003 fiscal year. This report will focus on comparing the results of the MWLAP's 2002 monitoring program with the 1990 objectives in order to assess attainment of the objectives. An extensive literature search and comprehensive review of historical data is not included in this report.

1.1 Burrard Inlet Water Quality Objectives

Microbiological objectives have been set for Burrard Inlet and include fecal coliform and enterococci as indicators. Monitoring of bacteriological indicators is important in order to assess the most sensitive water use designations of shellfish harvesting and recreation. Shellfish harvesting is closed in Burrard Inlet year-round due to high fecal coliforms levels in tissue. Consequently, the most sensitive water use in Burrard Inlet that could be affected by bacterial contamination is recreation. Water-based recreational-use of Burrard Inlet is high. Activities such as power boating, sailing, fishing, canoeing, kayaking, dragon-boating, windsurfing and swimming are common in various parts of the inlet. When the 1990 objectives were established, the Medical Health Officer recommended against primary-contact water-based recreational activities (i.e. swimming) in False Creek due to water quality concerns. Consequently, the Burrard Inlet microbiological objectives do not currently apply within False Creek. Due to increasing residential development and recreational use, as well as changes in the discharges released directly into False Creek, the Ministry has undertaken a separate review of the False Creek microbiological water quality objectives (Phippen 2004). A secondary-contact objective for enterococci is being proposed for False Creek.

The last microbiological objective attainment monitoring conducted by the MWLAP was in 1995. This monitoring found that the fecal coliform objective was not met at Deep Cove, Cates Park, Brockton Point and Ambleside. The GVRD monitors fecal coliform at bathing beaches in Burrard Inlet during the recreation season (April to October). These data are used by the Vancouver Coastal Health Authority to assess beach water quality and determine whether beaches should be closed. Although fecal coliforms have traditionally been monitored in Burrard Inlet, research shows that in marine waters enterococci is a better indicator of gastrointestinal illnesses (EPA, 1986). Enterococci has not been sampled regularly by either the MWLAP or the Greater Vancouver Regional District (GVRD). The last MWLAP attainment sampling for enterococci was conducted in 1992 when all areas sampled met the objectives. A special

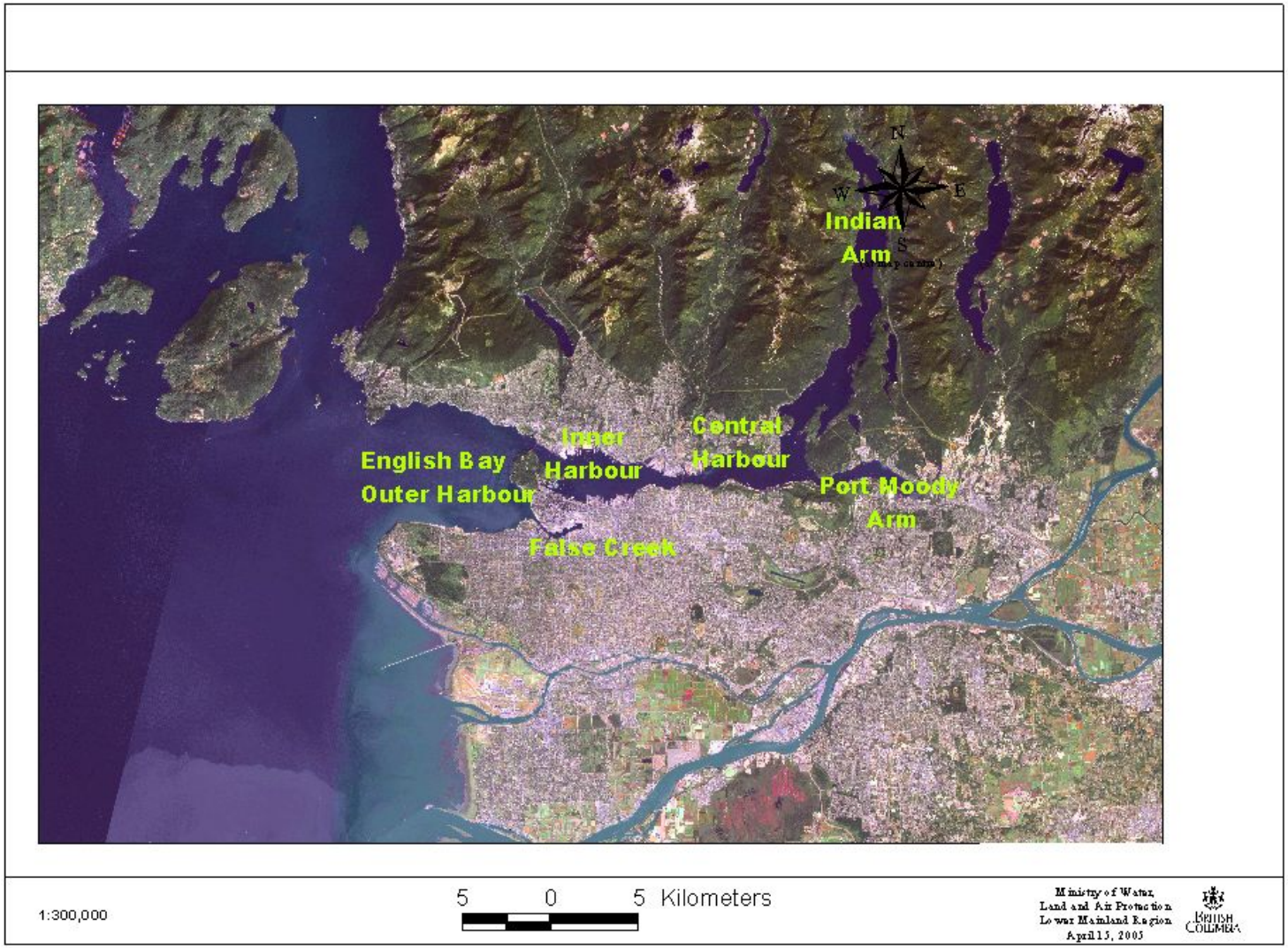


Figure 1: The sub-basins of Burrard Inlet

monitoring program was conducted by the Friends of False Creek, Greater Vancouver Regional District and Ministry of Water, Land and Air Protection in 2002 to support the False Creek water quality objectives review. This monitoring program included weekly monitoring of enterococci at 30 sites in False Creek for one year.

Other water quality objectives set for Burrard Inlet include those for dissolved oxygen, pH, suspended solids, turbidity, chlorine-produced oxidants, weak acid dissociable cyanide, ammonia, metals and un-dissociated hydrogen sulphide. Dissolved oxygen is an important water quality parameter as it is essential for the respiration of most aquatic organisms. pH is a measure of alkalinity/acidity which can harm aquatic life when too high (basic) or too low (acidic). Suspended solids measures the amount of sediment in the water column while turbidity measures the reduction of light passing through water due to particulate matter in the water. Both total suspended solids and turbidity are important water quality parameters as their elevation in the water column can reduce the ability of phytoplankton and macrophytes to photosynthesize, smother benthic habitats upon settling and physiologically stress fish and invertebrates. Chlorine-produced oxidants is measured in marine waters as a surrogate for total residual chlorine, while weak acid dissociable cyanide measures the amount of cyanide in the water, and ammonia nitrogen measures the most biologically available form of nitrogen. Chlorine, cyanide and ammonia are all of concern in the marine receiving environment due to their toxicity to aquatic life. Metals are also measured in water and sediment as some may be acutely toxic or may exert chronic stress on aquatic life. Sulphide, measured as un-dissociated hydrogen sulphide, can also be toxic to marine aquatic life.

Water quality objectives for organic substances in Burrard Inlet include sediment and tissue objectives for total polychlorinated biphenyls (PCBs). PCBs are synthetic oils that may affect development, growth and reproduction. PCBs are particularly harmful to consumers of contaminated prey as they are relatively resistant to degradation and may accumulate in animal tissues when released or spilled into the environment. Due to their affinity for lipids and resistance to degradation, PCBs have been found to bio-magnify in the food web and harm higher trophic levels such as seals and killer whales (Grant and Ross 2002).

Other organic contaminants that have objectives set in Burrard Inlet include phenols, chlorophenols, styrene, tributyl tin, 1,2-dichloroethane and polycyclic aromatic hydrocarbons (PAHs). Phenols and chlorophenols are aromatic hydroxyl compounds. The chlorophenol objectives for Burrard Inlet have been set for water, sediment and fish tissue while the phenol objective was set for water only. These objectives were set to protect aquatic life as well as to prevent fish tissue from becoming tainted (Warrington 1997). Styrene is a volatile hydrocarbon that may also cause the tainting of fish tissue. The styrene objective set for the water column was set to protect against this (CCME 1999). Tributyl tin is an organotin compound commonly used as an anti-fouling agent. It may be toxic to aquatic life and have endocrine disrupting properties. The Burrard Inlet objective for tributyl tin has been set for the water column to protect aquatic life from toxicity. Ethylene dichloride (1,2-dichloroethane) is not toxic to marine aquatic life; however,, an objective was set for water in order to protect humans from consuming contaminated aquatic organisms. PAHs are a group of organic compounds with two or more benzene rings in their structure. Aquatic organisms may take up PAHs from water, sediment and food. The metabolism of PAHs results in intermediate byproducts which are toxic, carcinogenic and/or mutagenic (CCME 1999). As PAHs tend to partition and accumulate in sediments, Burrard Inlet objectives to protect aquatic life are set for PAHs in sediment.

Limited water column sampling in 2000 did not find, or was unable to determine (due to laboratory detection limits), values in excess of PCBs, metals and MTBE in Burrard Inlet. The sediment sampling found values in excess of PCBs, all PAH species and all metals for which there are marine sediment objectives set in Burrard Inlet. Many of the other above parameters were last measured in Burrard Inlet in 1994. Turbidity, ammonia, cyanide, tributyl tin, ethylene dichloride, styrene, chlorophenols, pH and many metals in water, as well as chlorophenols in sediment and fish, and PCBs in fish were found to meet their respective objectives (MELP 1996). At times, chlorine produced oxidants, dissolved oxygen, suspended solids, some metals (copper, iron and lead) and phenols in water, as well as metals (cadmium, copper, lead, nickel and zinc), PCBs and PAHs in sediment did not meet the objectives. The 1994 provincial

attainment monitoring report recommended that due to the importance of Burrard Inlet and the number of objectives not met, attainment monitoring should continue. As comprehensive attainment sampling has not occurred since 1994, it became a priority to monitor Burrard Inlet in 2002.

2.0 OVERVIEW OF THE STUDY AREA

2.1 Location

Burrard Inlet is located in the Lower Mainland and is defined as the waterbody east of Point Atkinson and Point Grey (Figure 1). The inlet is often divided into sub-basins such as the outer harbour, False Creek, inner harbour, central harbour, Port Moody Arm and Indian Arm. The 2002 monitoring program included sampling sites in each of these sub-basins.

2.2 Hydrology and Oceanography

The Burrard Inlet watershed receives large amounts of freshwater from: Capilano River, Mosquito Creek, MacKay Creek, Lynn Creek, Seymour River, Noons Creek, Indian River and the Buntzen Power Plant which diverts water from Coquitlam Lake. Most of these freshwater sources are driven by the wet coastal climate and thus their discharges peak with rainfall in the fall and winter, followed by an additional but lower peak in the spring during freshet (EVS Environment 1995). During freshet the Fraser River also has a large influence on Burrard Inlet, especially in the outer harbour.

Tidal currents in Burrard Inlet are responsible for most of the mixing and flushing in the inlet (Nijman and Swain 1990). The mean tide is approximately three metres with a maximum of approximately five metres. The maximum current speed is approximately six knots at the constrictions at both First and Second Narrows and ranges between 0.5 – 1.0 knots elsewhere.

The outer harbour is deep where Burrard Inlet opens to the Strait of Georgia and is influenced by the Fraser River runoff more than other parts of the inlet. False Creek is the shallowest area in the inlet with depths ranging between 4-8 m. Circulation is restricted in False Creek as there is little freshwater input as well as a sill under the Cambie Street Bridge limiting water circulation and flushing (Nijman and Swain 1990). Due to the poor water exchange in False Creek, this area is sensitive to water quality impacts. Burrard Inlet is also relatively shallow between First Narrows and into Port Moody Arm. The inner harbour has a mean depth of 21 m and has good mixing due to the large currents present at First and Second Narrows. Port Moody Arm is relatively shallow with little direct freshwater inflow and thus it is largely influenced by the rest of Burrard Inlet. Indian Arm is quite different than the other parts of Burrard Inlet as it is a typical fjord with steep walls and a deep basin.

2.3 Water Uses

Burrard Inlet is a heavily used urban inlet important for recreation, marine shipping and fisheries resources. Recreational uses include swimming at local beaches, kayaking, rowing, dragon-boating and wind-surfing, as well as sailing and power boating. Swimming beaches are located around English Bay (Kitsilano, Jericho and Locarno), West Vancouver (Ambleside, Dundarave, Whytecliffe Park and Lighthouse Park), Deep Cove (Cates Park) and Port Moody Arm (Barnett Marine Park). Throughout the inlet, protected anchorages harbour many marinas and yacht clubs as well as floating homes. Facilities which rent boats, kayaks, canoes and wind-surfing gear are located in Deep Cove, Port Moody Arm, West Vancouver, False Creek and English Bay. Scuba diving occurs off the shores of West Vancouver and Deep Cove, while camping also occurs along the shores of Indian Arm. Sport fishing is also a popular activity throughout the Inlet.

Industrial activities have bordered Burrard Inlet since the mid-1800's, being largely concentrated in False Creek and the inner harbour. Burrard Inlet is also a major port of entry into Canada. The outer harbour provides temporary mooring for cargo and passenger vessels enroute to the Port of Vancouver. The Port of Vancouver facilities, such as passenger terminals for cruise ships and port facilities for the shipment of bulk commodities, are concentrated between First and Second Narrows. The Port of Vancouver is the

second busiest port on the North American West Coast (in terms of total cargo volume) and is number one in Canada in terms of total cargo handled (Port Vancouver 2003). While industrial and large-scale commercial use in the inner harbour continues to grow, False Creek has been undergoing a transformation from a major industrial area to a more residential and commercial area since the world exposition occurred along its shores in 1986. Further development around its shoreline for the upcoming 2010 Winter Olympics will continue to follow this trend. Indian Arm continues to remain the least developed sub-basin in the inlet.

The marine waters of Burrard Inlet and the freshwaters discharging into the inlet support much aquatic life and wildlife. The inlet is important for fisheries resources and has been found to be very productive in the past. Important salmonid resources which use the inlet include coho, pink and chinook salmon. Each year hundreds of thousands of juvenile salmonids enter Burrard Inlet from the Capilano, Seymour and Indian rivers, as well as from other smaller creeks. Besides being an area which salmonids migrate through between their spawning grounds and the ocean, Burrard Inlet is also a rearing area for juvenile fish. Other fish species found within Burrard Inlet include: flathead and English sole, starry flounder, anchovy, smelts, sticklebacks, sculpins, tomcod, Pacific dogfish, striped and shiner perch. False Creek has also been identified as an important rearing area for herring, steelhead, chum, coho, chinook and sockeye salmon while the mud flats in the inner harbour east of Second Narrows provide rearing habitat for juvenile salmonids. As well, herring spawn between Point Atkinson and Ambleside while smelt spawn from First Narrows through English Bay to Spanish Banks.

The fisheries resources of Burrard Inlet have historically been important to the local First Nations people, as well as for commercial and recreational fisheries. Recreationally and commercially important chinook, sockeye, coho, herring, hake, flounder, rock cod and ling cod fisheries are found in the outer harbour. Other commercially important fisheries that have been supported in Burrard Inlet include those for dungeness crab, pandalid shrimp and prawns. Many recreational fishers harvest crabs in English Bay, off West Vancouver, around Roche Point and in Indian Arm while bivalve harvesting is closed in the inlet due to fecal coliform contamination of the bivalve tissue. Marine mammals such as harbour seals, California and Stellar sea lions and killer whales may also use Burrard Inlet and since the inlet is on the Pacific Flyway route, it is also a migratory stop for many waterfowl.

3.0 POTENTIAL SOURCES OF CONTAMINATION

The 1990 Burrard Inlet WQ Objectives report states that most of the contamination in Burrard Inlet arises from bulk loading facilities, oil refineries, chemical plants, combined sewer overflows and stormwater discharges. Permits set allowable levels of parameters of concern to be discharged into the receiving environment. Activities not under permit which may also affect water quality include combined sewer and stormwater discharges and discharges from boats and marinas, as well as general surface runoff. Water, sediment and biota impacts have been recorded near the location of some of these permitted and non-permitted discharges into Burrard Inlet. This section provides information on some of the permits issued for discharges to Burrard Inlet as well as some of the potential contaminants. (This section will not provide a comprehensive update of amended, cancelled or new permits).

Outer Harbour

The Lions Gate wastewater treatment plant (WWTP) is the only permitted discharge into the outer harbour. The WWTP discharges domestic and some industrial waste after primary treatment. Sludge from the WWTP used to be discharged to the Outer Harbour on ebb tides; however,, this was discontinued in 1992 (EVS Environment Consultants *et al*. 1995).

False Creek

Impacts from historical contamination as well as CSO and stormwater discharges in False Creek are greater than those from the currently permitted operations. Possible remediation of the contaminated False Creek sediments is being investigated under a separate initiative. Permits currently exist for the discharge of cooling water from the Plaza of Nations and for the discharge of storm and cooling water

from a ready-mix cement plant. The potential contaminants of concern from these discharges are elevated temperatures from the cooling water, and suspended solids from the cement plant stormwater.

Discharges into False Creek which are not under permit include: discharges from marinas and pleasure craft, five combined sewer outfalls and ten stormwater outfalls (Phippen 2004.). CSO discharges and urban stormwater may contribute to elevated bacteriological, nutrient, PAH, PCB and metals concentrations into receiving waters.

False Creek is heavily used by recreational vessels. There are more than 1,600 boats moored in False Creek and marina expansion is ongoing (Phippen 2004). As many of the pleasure craft and commercial fishing vessels in the inlet may not have holding tanks for their sanitary waste, impacts to the water quality in False Creek from boat moorage are possible. Potential contaminants from the heavy boating usage include bacteria associated with sewage, PAHs from fuel and tributyl tin from anti-fouling paints. The expansion of marinas and residential developments as well as the increase in boat use and recreational activities, combined with the limited flushing in the inlet, elevate the potential risks of the contamination of False Creek. In addition, a recent proposal has been made to create a beach within the east basin of False Creek. Elevated bacteriological levels in marine waters may affect primary and secondary contact recreation uses that could occur with this proposal.

First to Second Narrows

Permits for discharging into Burrard Inlet between First and Second Narrows include three for bulk loading terminals, and one for each of the following: cooling water from a sugar refinery, discharge from the public aquarium, and washwater and stormwater discharges from a ready-mix plant. The bulk loading terminal just east of the Lions Gate Bridge had the largest impact of these permitted discharges (Nijman and Swain 1990). The other permitted discharges between First and Second Narrows are not anticipated to have significant effects if effluent is maintained within permit levels.

There are also combined sewer outfalls which discharge into the Inner Harbour, from both the south shore and the north shore. The Clark Drive CSO discharges the largest volume of any of the CSOs that enter Burrard Inlet, contributing almost 80% of the CSO discharge to the Inner Harbour and 70% of the total CSO discharge to Burrard Inlet (EVS 1995). Consequently, the Inner Harbour receives the largest contaminant loading from CSOs. Under the GVRD LWMP there are a number of operational and site-specific management options that have been, and will be, investigated and utilized in the Clark Drive catchment in order to decrease the environmental effect of this CSO on Burrard Inlet until it is separated (GVRD, 2001).

There are also a large number of stormwater outfalls that discharge into the Inner Harbour. Urban stormwater may contribute bacteriological contamination, as well as nutrients, metals, PAHs, sediment and BOD, to watercourses. Marinas in the inner harbour may also contribute bacteria, suspended solids, ammonia, BOD, fuel oil emissions and anti-fouling paints to the inlet (Nijman and Swain 1990). Some of these contaminants have been found in Coal Harbour where there is a marina as well as a CSO. Localized impacts of CSO and storm outfalls are anticipated near each outfall.

Freighters and cruise ships in the inner harbour are another potential pollution source. Potential contaminants from these vessels include fecal coliforms, ammonia, BOD and suspended solids. As the cruise ship industry has grown significantly in Vancouver since 1990, the significance of this pollution source; however, is not known.

Second Narrows to Roche Point

There are many permitted discharges between Second Narrows and Roche Point. These include permits for a lubricating oil reprocessing facility, a chlor-alkali plant, a sodium chlorate plant, a ready-mix concrete batch plant, a crude oil ship terminal and tank farm, two petroleum bulk handling facility and an oil refinery. Most of these discharges were not expected to have significant impacts if effluent quality were within the permit conditions (Nijman and Swain 1990). The sodium chlorate processing plant could potentially cause toxicity problems in Burrard Inlet if sodium chlorate is discharged and converted to free

chlorine in the water. On occasion there has been high phenol and oil and grease concentrations, as well as oxygen demand from the petroleum bulk handling facility discharges (Swain and Nijman 1990).

There are two combined sewer outfalls discharging from Burnaby into this portion of the inlet. The impact from these CSO discharges is anticipated to be much less than the English Bay and Vancouver Harbour CSO discharges although the types of impacts would be similar. The stormwater discharges in this area are not a large contaminant source into Burrard Inlet however, they are a concern near bathing beaches (such as Cates Park), which may be deleteriously affected by bacterial contamination.

Port Moody Arm
Port Moody Arm (PMA) was found to have a high incidence of liver lesions in English (Goyette and Boyd 1988) likely due to a former petroleum refinery waste water discharge. The former refinery is currently a bulk handling facility and discharges stormwater from it's onsite operations. The other permit to discharge effluent into PMA includes cooling water from a natural gas fired electrical generating station.

Discharges from the cooling water of the thermal plant use chlorine used to prevent bio-film formation in the circuits but are required to de-chlorinate prior to discharge to PMA. Extensive studies were completed by BC Hydro on the potential effects of cooling water discharge on aquatic life in PMA (Taylor et al. 2001, Greenbank et al. 2001, Birtwell et al.2001) . Stormwater is discharged into PMA from an oil refinery in the area. These discharges may contain oil and grease, phenols and PAHs, while two petroleum bulk loading facilities discharge treated stormwater and some sanitary sewage. Ethylene glycol and styrene monomers could enter PMA from the bulk loading facility's treated stormwater. The sediments near this site have been found to have high sulphur, lead and zinc levels (Nijman and Swain 1990). Two chemical processing plants may also have localized impacts on PMA through the cooling water discharged into a local creek or from metals contamination from exfiltration ponds located on the near shore.

Two combined sewer outfalls and a few stormwater outfalls discharge into Port Moody Arm. Although no data existed in 1990 on the frequency, duration or magnitude of this overflow, the magnitude is expected to be lower than the other CSO's discharging into Burrard Inlet (Nijman and Swain 1990). Stormwater also discharges into PMA although these discharges are not anticipated to be a concern except when discharged near bathing beaches. Lastly, a large marina is located in PMA as well as some live-aboard and houseboats. Hydrocarbons, tributyl tin and other anti-fouling materials, nutrients and bacterial contamination are possible from marina related activities.

Indian Arm
There are currently no permitted discharges nor combined sewer outfalls which discharge directly into Indian Arm. There are a few stormwater outfalls which discharge into Deep Cove with relatively minor loading concerns. The largest concern with these outfalls is the potential bacteriological contamination of Deep Cove which is a highly used recreational area with a swimming beach and heavy kayak and canoe usage. Local beaches have frequently been closed to swimming in the past due to high bacteriological concentrations. Marinas and a yacht club also exist in Deep Cove which may also contribute to localized water quality impacts. Possibly increasing the number of treated sewage outfalls in the Indian Arm area is currently a multi-agency issue.

4.0 METHODOLOGY

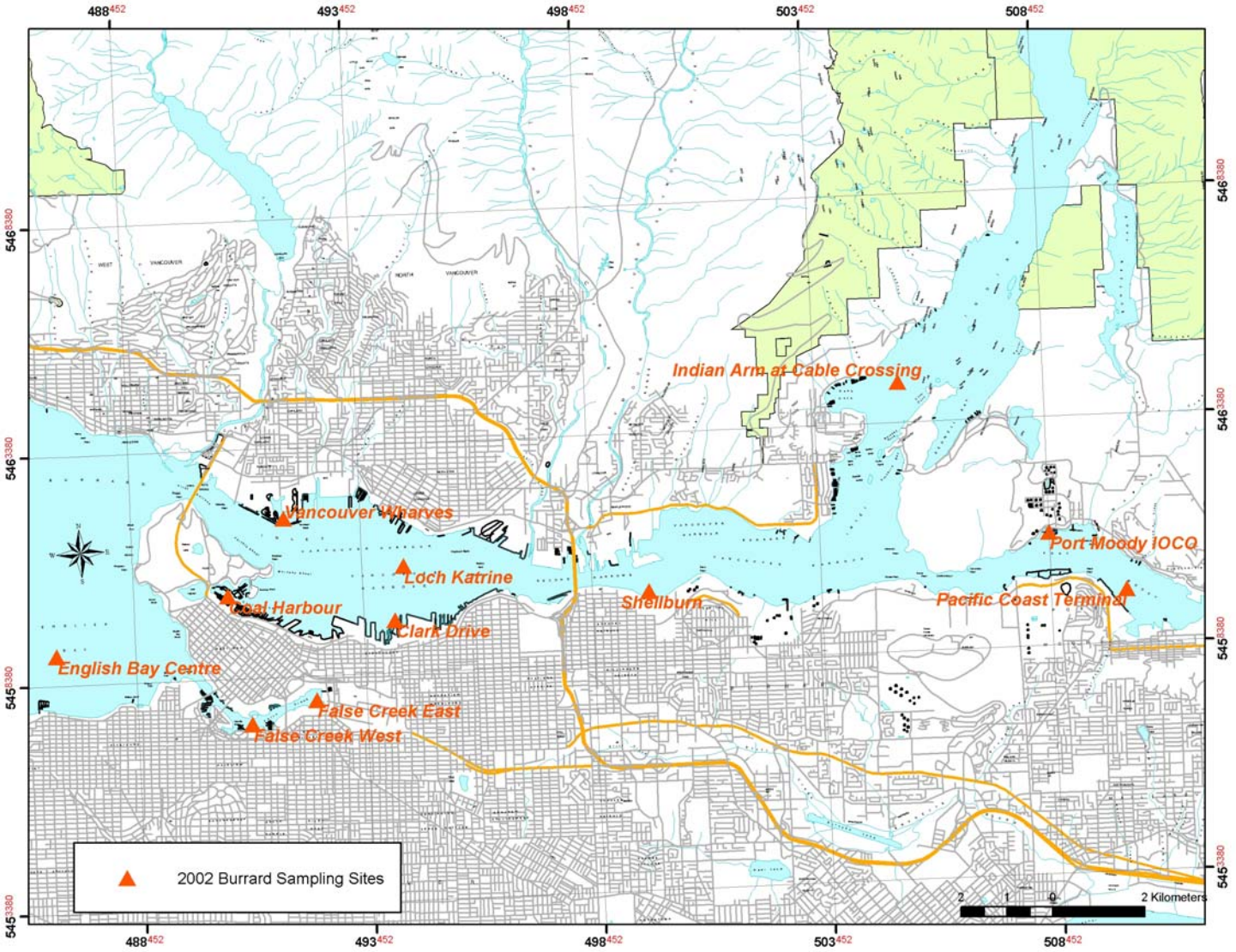
In 2002, water quality monitoring locations included English Bay Centre (0300076), False Creek East (E207814), False Creek West (E207815), Vancouver Wharves (E207816), Coal Harbour (E207813), Clark Drive (E207818), Loch Katrine (E207819), Shellburn (E207822), Ioco (E207823), Pacific Coast Terminals (E207698) and Indian Arm (0300080) (Figure 2). Water samples were collected from a boat on October 2, 9, 16 and November 14 and 21, 2002. Sampling was conducted on both flood and ebb tides. Surface water samples were collected directly into the appropriate sample containers. Water samples were also collected from deeper waters in False Creek East and Vancouver Wharves using a 3-litre Van Dorn sampler which was lowered to the desired depth and then triggered.

Analyses conducted on the marine water samples included: fecal coliform, enterococci, pH, dissolved ammonia-nitrogen, non-filterable residues and total metals (arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel and zinc). Not all parameters were measured at all sites. Sampling quality control was addressed by including field blanks and collecting blind duplicates on each sampling date. Samples were kept on ice in a cooler and dropped off at CanTest Laboratory (bacteriological samples) and Philip Analytical Services (chemical samples) on the sampling day. Procedures in '*Ambient Fresh Water and Effluent Sampling Manual*' (RIC 1997) were followed for these analyses.

Field measurements taken included water temperature, salinity and dissolved oxygen, at surface and at depth at each site on each sampling date (if the total depth at the site was less than 10 m, then measurements were taken at the maximum depth, if the total depth was greater than 10m, then 20m was the deepest measurement taken). Measurements were made with a Yellow Springs Instrument meter (model 556 multiprobe system) which was calibrated prior to use each day.

Sediment samples were collected using a petite ponar sampler at all of the water sampling sites with the exception of the False Creek sites. Sediment samples at each site were collected using a petite Ponar sampler. Sediments for chemical analyses were collected from the surface layer of each grab sample. Samples were analyzed for particle size distribution, total organic and inorganic carbon, trace metals, polychlorinated biphenyls (PCB's), polycyclic aromatic hydrocarbons (PAHs) and chlorinated phenols. After collection, samples were stored on ice in a cooler and were delivered to Philip Analytical Services on the same day. Samples were not collected in False Creek as Environment Canada was conducting a more comprehensive sediment sampling program in False Creek in 2002.

Integrated Resources Consultants Inc. collected fish samples for tissue analyses in January and February, 2003. An otter trawl was used to collect English sole (*Parophrys vetulus*). After collection, fish tissue samples were frozen, stored in a freezer, and delivered to Philip Analytical Services within approximately one week of the sampling date. Fish tissue was analyzed for lead, mercury and PCBs.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Indian Arm at Cable Crossing
Vancouver Wharves
Port Moody IOCO
Loch Katrine
Shellburn
Pacific Coast Terminal
Coal Harbour
Clark Drive
English Bay Centre
False Creek East
False Creek West
2002 Burrard Sampling Sites
2 1 0 2 Kilometers

5.0 RESULTS AND DATA ANALYSES

5.1 Water Quality Indicators

5.1.1 Microbiological

The Burrard Inlet ambient water quality objective for fecal coliforms is that the geometric mean (calculated from a minimum of five samples in 30 days) be less than or equal to 200 fecal coliforms per 100mL. Although the samples were not collected in 30 days due to time constraints, the data from the five sampling dates (in 50 days) were still used to check attainment with the microbiological objectives. We felt that as the samples were still all collected in the fall, this comparison is reasonable. The objective was exceeded at only the False Creek East site (239 /100 mL) (Figure 3). The microbiological objectives do not apply in False Creek as recreation is not a designated water use. The fecal coliform objective was met at all of the other sites where it did apply. . The Ministry intends to designate False Creek for primary contact recreation in the future.

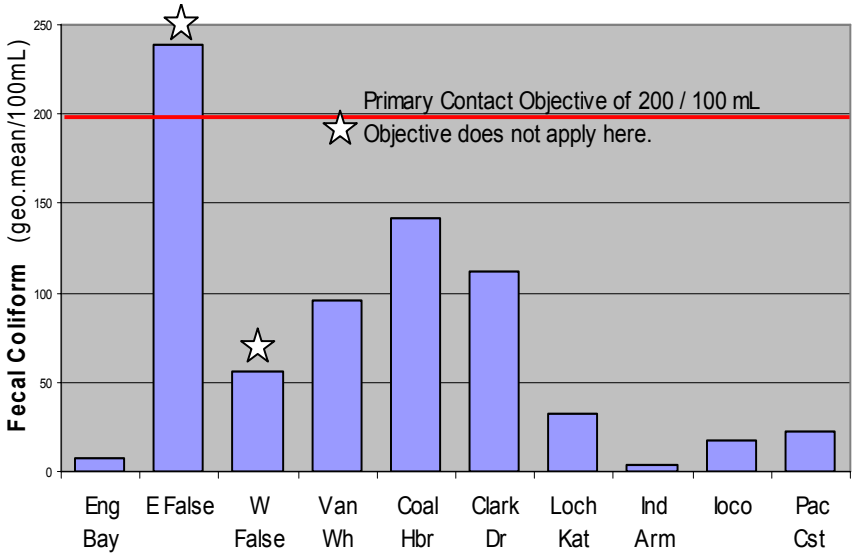


Figure 3: Fecal coliform concentrations (geometric mean) at each site (n = 5).

The Burrard Inlet ambient water quality objective for enterococci is that the geometric mean be less than or equal to 20 enterococci per 100mL. This objective was exceeded at seven of the ten sites monitored including: False Creek East and West, Vancouver Wharves, Coal Harbour, Clark Drive, Loch Katrine and Pacific Coast Terminals (Figure 4). Again, these objectives do not apply to False Creek. The greatest value in excess of the objective was at Coal Harbour where the calculated geometric mean (104 /100mL) was approximately five times higher than the objective set to protect primary-contact recreation. At the other sites which exceeded the objective, the values ranged from being just over the objective to being approximately double.

Individual microbiological values at most sites were highest on November 14th or 21st, 2002 (Table 2). Rainfall preceded these sampling dates, whereas dry conditions preceded the three other sampling dates (Figure 5). The sampling date with the greatest amount of rainfall preceding it (in the previous 48 hours) was November 14th. This date coincided with the highest fecal coliform and enterococci concentrations recorded at many of the sites. It is likely that if five samples had been collected prior to heavy precipitation, fewer sites would have exceeded the objective since it was a dry year. Alternately, had the five samples all been collected after a rain event, more or all of the sites may have exceeded the objectives.

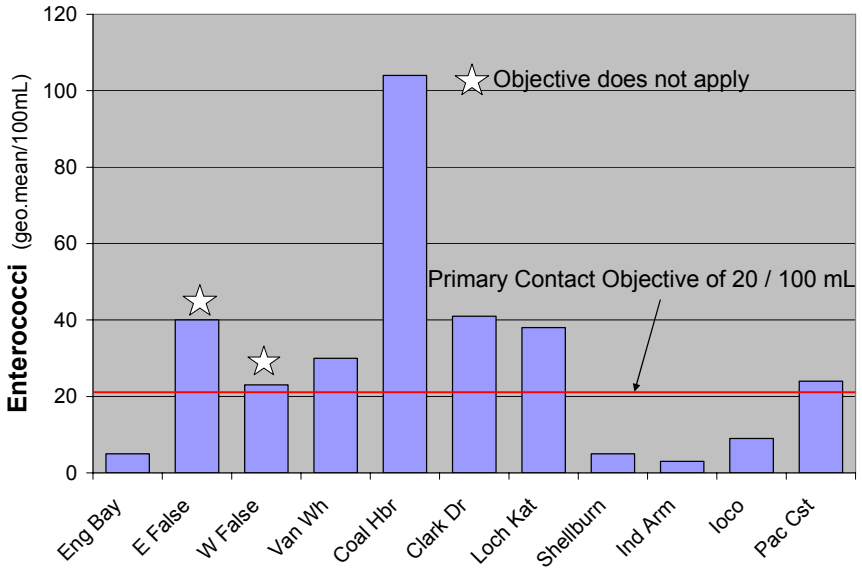


Figure 4: Enterococci concentrations (geometric mean) at each site (n=5). The highest single sample values of both fecal coliform and enterococci were recorded at False Creek East and West, Clark Drive, Loch Katrine and Coal Harbour. Excluding Loch Katrine, these sites are in the direct vicinity of combined sewer outfalls. Stormwater runoff and/or CSO discharges thus likely contributed significantly to these bacterial elevations.

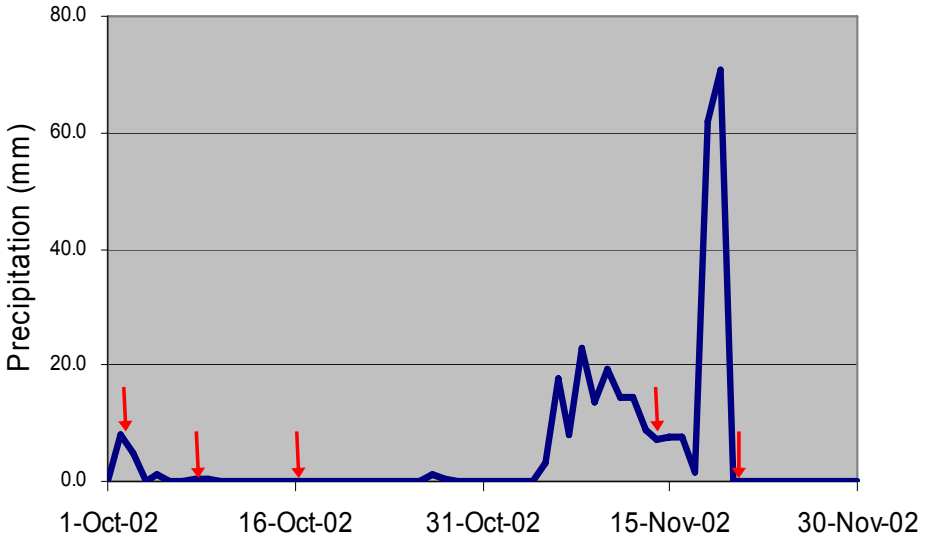


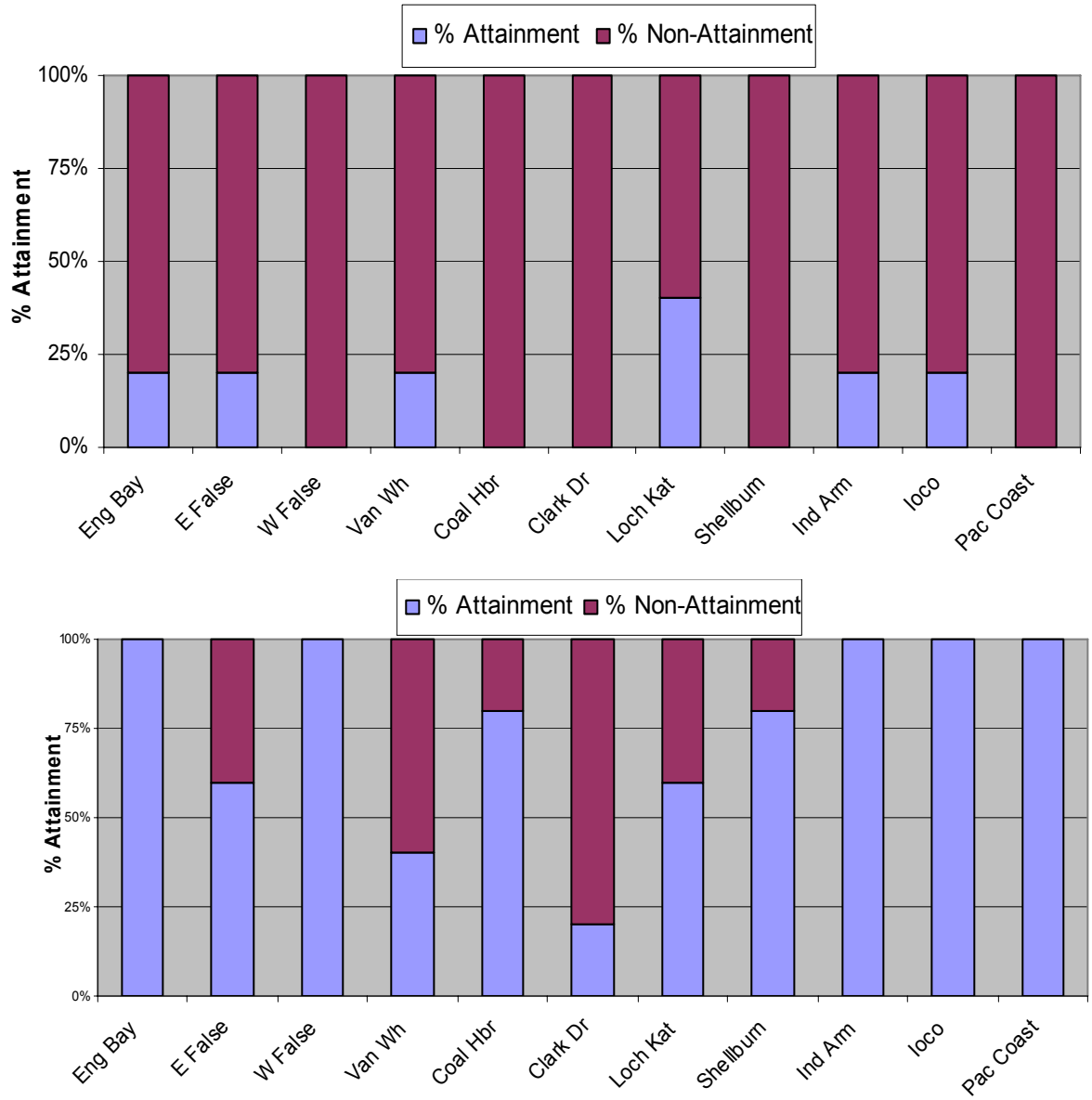
Figure 5: Precipitation data for October and November from GVRD sampling site in Stanley Park. (Arrows indicate sampling day.)

5.1.2 Dissolved Oxygen

The minimum objective for dissolved oxygen (DO) in Burrard Inlet is 6.5 mg/L (this is a long-term objective between First Narrows, Second Narrows and into Port Moody Arm). Only 11% of the DO measurements taken at depth met this minimum objective, with False Creek West, Coal Harbour, Clark Drive and Shellburn never reaching the minimum objective (Figure 6). The dissolved oxygen concentrations in surface waters met the minimum objective more frequently (78% attainment in surface waters versus 11% attainment in deeper waters) (Figure 7). Non-attainment of the minimum DO objective

occurred on occasion in surface waters at False Creek East, Vancouver Wharves, Coal Harbour, Clark Drive, Loch Katrine and Shellburn (Table 1). Clark Drive and Vancouver Wharves dissolved oxygen concentrations failed to reach the minimum DO objective the most frequently (70% of the surface and depth measurements did not meet the objective at these sites). The lowest DO measurements occurred at False Creek East on the last three sampling dates (3.0 to 3.6 mg/L) (Table 2).

Figure 6: Percent of dissolved oxygen measurements in water at depth (from 5m to maximum 20m) which were not in attainment with the objective (n = 5).Figure 7: Percent of dissolved oxygen measurements in surface water which were not in attainment with the objectives (n = 5).



Dissolved oxygen field measurements taken at each site indicate that there is a widespread dissolved oxygen problem in Burrard Inlet. Previous attainment sampling found dissolved oxygen to be a concern at only a few sites such as in False Creek and Port Moody Arm in 1994, and in False Creek and English Bay in 1993. In 1992; however,, DO in surface waters were found to not meet the objective at all sites tested. Based on the 2002 data, dissolved oxygen concentrations in Burrard Inlet remain a widespread problem for the protection of aquatic life in both surface and deeper waters.

5.1.3 Suspended Solids

The water quality objective for suspended solids (measured as non-filterable residue) is that the measured value should not be more than 10 mg/L above background or control conditions. English Bay Centre was considered a control or background site, and thus the measured values at other sites were compared to the values at this site. There was only one non-attainment with the objective which occurred at Shellburn on October 16th (dry weather conditions) (Tables 1, 2).

The suspended solids data collected in the 1990's also had few values in excess of the objective at only a few sites. Similar to the 2002 monitoring results, in 1994 the objective for suspended solids was not met at sites between First Narrows and Roche Point (Chevron, Clark Drive, Coal Harbour), whereas in 1993 the objective was met at all sites sampled. In 1992, the suspended solids objective was generally met except at False Creek East and Locarno.

A previous investigation found that the rivers and creeks flowing into Burrard Inlet are the largest overall contributors of suspended solids to the inlet. The LGWWTP and the Clark Drive CSO are also significant TSS contributors to the Outer Harbour and Inner Harbour, respectively (EVS Environment Consultants 1995). As these discharges are impacted by rainfall events, much of the TSS concentrations are therefore also precipitation-driven and thus the low rainfall in the fall of 2002 may have influenced the results.

5.1.4 Ammonia

Ammonia concentrations in Burrard Inlet were low at most sites on most dates with many of the measurements being below the laboratory detection limit of 0.005 mg/L. The highest ammonia concentration (0.098 mg/L) was measured at False Creek East on the last sampling date (Table 3). This ammonia concentration; however,, was still 25 times lower than the maximum ammonia water quality objective of 2.5 mg/L. At every site, the ammonia concentrations were also well below the average or chronic objective of less than 1 mg/L (Table 1). The highest average ammonia concentration was approximately 20 times less than this objective. The two samples collected at depth and tested for ammonia (False Creek East and Vancouver Wharves sites on October 9th) were also well below the maximum and average water quality objectives for ammonia.

Elevated ammonia concentrations do not appear to be a problem at the sites sampled in Burrard Inlet in 2002. Values were much lower than both the maximum and average objectives established to protect aquatic life. The 2002 results are similar to the 1993 and 1994 results which showed that the ammonia objectives were met on all occasions.

5.1.5 pH

The water quality objective for pH in Burrard Inlet is that the pH should fall within the range of 6.5 – 8.5. This objective applies only to areas between Second Narrows and Roche Point. Shellburn was the only site in this sub-basin that was sampled in 2002. The pH at Shellburn ranged between 7.5 – 7.7 and thus met the objective (Table 3). pH was also measured at the Indian Arm site for comparison purposes, and values were similar (7.3 – 7.9).

The 2002 data indicate that the pH between Second Narrows and Roche Point is near neutral and in attainment with the objective set for the protection of aquatic life. This supports the 1993 and 1994 monitoring data which found that the pH conditions in Burrard Inlet met the objective.

5.1.6 Metals

There were no values in excess of either the maximum or average objectives set for Burrard Inlet for the following parameters: arsenic, cadmium, chromium, lead, nickel and zinc (Table 1). Copper was the only metal analyzed which, on occasion exceeded its relevant objective in the water column. The maximum long-term objective for copper (3 µg/L) was reached or exceeded twice, once at False Creek West and once at Coal Harbour. The average long-term objective for copper of less than or equal to 2 µg/L was also possibly exceeded at these two sites as well as at False Creek East. These results indicate that copper concentrations in the water column in False Creek and Coal Harbour were at levels that could contribute to detrimental affects on aquatic life.

The 2002 results reflect conditions measured in 1993, 1994 and 2000 when cadmium, chromium, nickel and zinc met their respective objectives. There is also an apparent improvement in the water column concentrations of copper and lead. In both 1993 and 1994, the average and maximum copper objectives were exceeded at more sites in Burrard Inlet than in 2002. As well, the average lead objective was exceeded at many sites in Burrard Inlet in 1993 and 1994; however,, there were no values in excess of this objective in 2002. This trend towards lower lead concentrations likely reflects the removal of lead from gasoline. The apparent improved trend in water column metals concentrations in Burrard Inlet could be a reflection of stormwater improvements as metal concentrations in stormwater, on average, appear to be lower than in the 1980's (EVS Environment Consultants 1995). Another factor that could contribute to this apparent improving trend are improvements to the quality of effluents discharged. Alternately, these results could be a reflection of the dry weather conditions and therefore lower amounts of surface runoff during the sampling period. As the contaminant levels in the inlet water column appear to be related with precipitation patterns, it is difficult at this time to determine whether conditions have actually improved.

5.2 Sediment Quality Indicators

5.2.1 Metals

Of the parameters which have sediment quality objectives set for Burrard Inlet, there were no values in excess of the arsenic, chromium and nickel objectives (Table 1). Cadmium, copper, lead, mercury and zinc concentrations in sediment; however,, exceeded their respective sediment objectives at some sites. Most of these are long-term objectives.

The mercury objective for sediment was exceeded at Ioco as the mercury concentration was approximately four times higher than the objective. Mercury also exceeded its long-term objective in sediment at Coal Harbour, Clarke Drive and Loch Katrine (Table 1). The mercury concentration was highest at Clarke Drive, being eight times higher than the long-term objective value (Figure 8). As mercury may bioaccumulate and biomagnify up the aquatic food web, these elevations could be contributing to detrimental impacts on predators up the food chain.

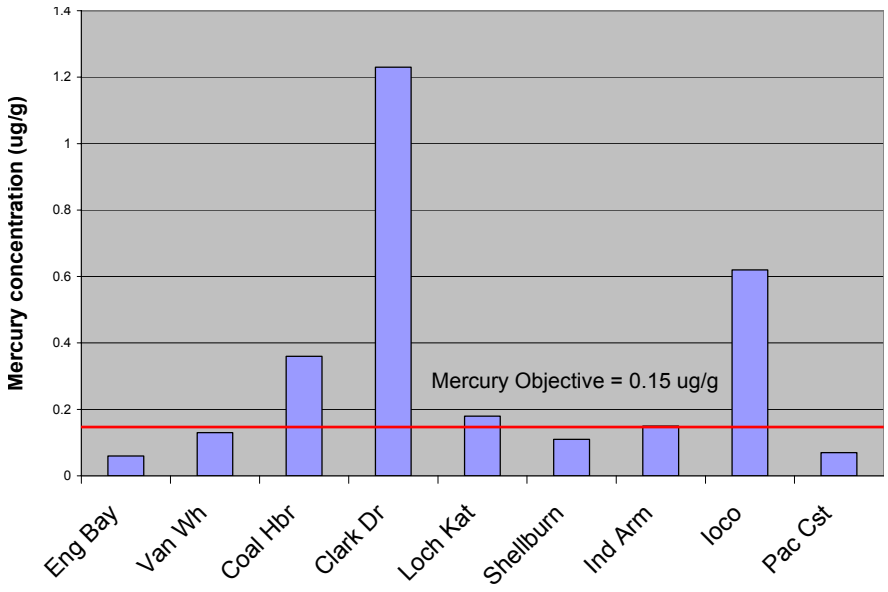


Figure 8: Mercury concentrations in sediment at each site sampled (n=1).

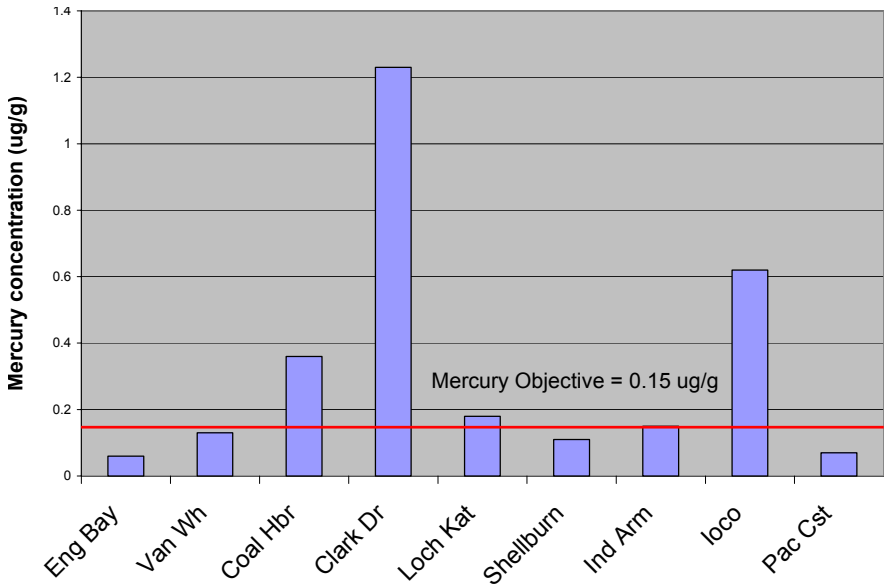


Figure 9: Mercury concentrations in sediment at each site sampled (n=1).

The long-term cadmium sediment quality objective was exceeded at Vancouver Wharves, Clarke Drive, Loch Katrine and Pacific Coast Terminals while the long-term copper objective was also exceeded at Vancouver Wharves and Clarke Drive, as well as at Coal Harbour (Table 1). The long-term lead objective was exceeded at Vancouver Wharves and Clarke Drive, as well as Coal Harbour, Loch Katrine and Pacific Coast Terminals while the long-term zinc objective was exceeded at Vancouver Wharves and Clarke Drive as well as Loch Katrine. Clarke Drive had the most number of values in excess of the sediment objectives followed by Vancouver Wharves, Loch Katrine and Coal Harbour; all of these sites are located in the inner harbour (Figure 9).

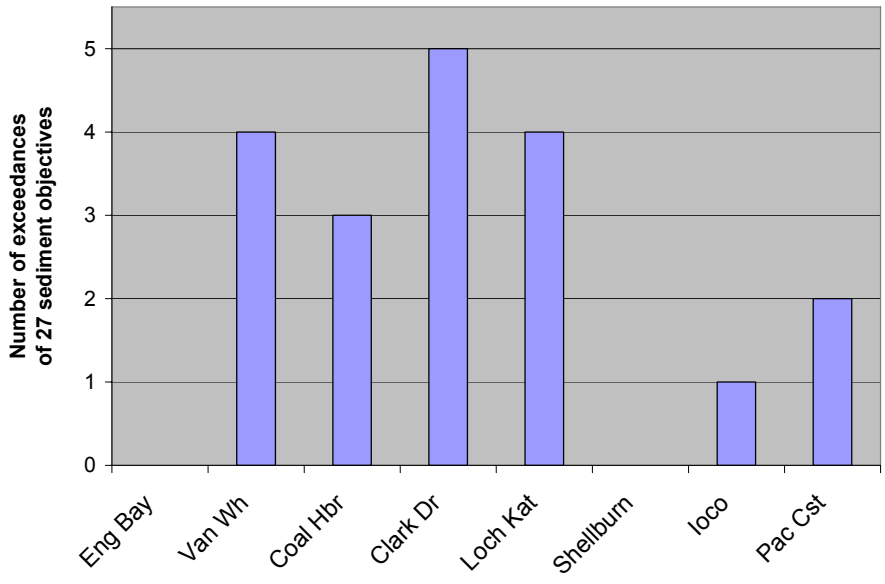


Figure 10: Number of values in excess of sediment objectives at each site.

These results indicate that cadmium, copper, lead, mercury and zinc are at concentrations in Burrard Inlet sediments that could contribute to aquatic life effects. The data also indicates that the Inner Harbour between First and Second Narrows has the greatest sediment metal contamination. In general, it appears that attainment of the Burrard Inlet sediment metal objectives has not improved between 1993 and 2002. While the data for arsenic and nickel concentrations may suggest improving trends, cadmium, copper, lead, zinc and mercury concentrations in the sediment exceeded their relevant objectives at many sites in 1993, 1994, 2000 and still in 2002.

5.2.2 PAHs

There was widespread number of values in excess of the long-term objective for total high molecular weight polycyclic aromatic hydrocarbons (PAHs) in sediment in the inner harbour and in Port Moody Arm (at the Pacific Coast Terminals site) (Table 1). The low molecular weight PAHs were almost equal to the long-term objective (0.5 µg/g) value at Loch Katrine and Pacific Coast Terminals. Individually, many of the PAHs analysed also exceeded their respective objectives, most often in the inner harbour and at Pacific Coast Terminals. Anthracene, benzo(a)anthracene, benzo-fluoranthenes, benzo(g,h,i)perylene, benzo(a)pyrene, chrysene, fluoranthene, fluorine, indeno(1,2,3-c,d) pyrene, phenanthene and pyrene all exceeded their respective objectives at some sites. PAHs have been a significant concern in Burrard Inlet previously as the 1993, 1994 and 2000 data also had many values in excess of objectives. In addition, PAHs were identified as a significant contaminant in Burrard Inlet Sediments by Environment Canada in 1988 (Goyette et al. 1988).

5.2.3 PCBs

The Burrard Inlet objective for total PCBs in sediment is 0.03 µg/g which was exceeded at both Coal Harbour and Pacific Coast Terminals (Table 3). The sediment PCB concentration at Coal Harbour (0.15 µg/g) was five times the objective value while at Pacific Coast Terminals, the concentration (0.2 µg/g) was close to seven times the objective. PCBs do not degrade quickly in the environment and favour partitioning into lipids. Consequently, PCB contamination can impact aquatic organisms as they bioaccumulate in tissues and biomagnify in predators higher up the food chain.

The 2002 data support the 1993, 1994 and 2000 data, which found that total PCB concentrations in sediment did not meet the objective at some sites. In 1993 and 1994 the PCB objective was exceeded at

Coal Harbour and False Creek East, while in 2000, the objective was exceeded at these two sites as well as Clark Drive and Ioco.

5.2.4 Chlorophenols

It was not possible to determine whether the chlorophenol concentrations exceeded the Burrard Inlet sediment quality objective of 0.01 µg/g since all of the chlorophenol concentrations measured were less than the laboratory detection limit, and the detection limit is higher than the objective value. Previous sampling in Burrard Inlet in 1993, 1994 and 2000 found that the chlorophenol concentrations in sediment did not exceed the relevant objective at the sites examined.

5.3 Fish Tissue Quality Indicators

5.3.1 Lead

The maximum objective of 0.8 µg/g of total lead in fish tissue was not exceeded in any of the English Sole tissue samples collected at any of the sites (Table 1). All of the fish tissue samples had less than the laboratory detection limit (0.1 µg/g) of total lead (Table 5). Data from 1994 support the 2002 results as it was found that lead concentrations in the fish tissue met the objective at all sites sampled.

5.3.2 Mercury

The maximum objective of 0.5 µg/g of total mercury in fish tissue was not exceeded in the English Sole tissue samples at any of the sampling sites (Table 3). Three of the four sites which had mercury analyses conducted on the tissue samples had levels less than the laboratory detection limit (0.05 µg/g). The English Sole tissue collected near the Shellburn site had a concentration of 0.02 µg/g in the fish tissue (Table 5). The data collected in 1994 are similar to the data collected in 2002 as the English sole tissue sampled also met the objective for mercury.

5.3.3 PCBs

The maximum total polychlorinated biphenyls objective of 0.5 µg/g of in fish tissue was not exceeded in any of the English Sole tissue samples collected in Burrard Inlet in 2002 (Table 5). All of the English Sole tissue samples had less than the laboratory detection limit (0.2µg/g) of total PCBs. Fish tissue sampled in 1993 and 1994 also met the relevant PCB objective.

5.4 Trend Indicators

Since 1992, attainment monitoring has not occurred consistently from year to year at all monitoring stations. There are some key sites, however, that have had three to five years of attainment monitoring data collected. These sites were used to assess whether any trends in pollutants of concern were discernable. Due to inadequate sample size, no statistics were used to examine trends, only a simple observation of whether a contaminant concentration was decreasing, increasing or remaining the same.

Most trend observations were made on sediment chemistry data. One marine water column trend to note is that water column lead objectives were historically not always met at some monitoring stations prior to1994 However, in 2000 and 2002, this objective was met at all stations.

The sediment monitoring stations that had enough attainment monitoring data to make an observation were Vancouver Wharves (E207816), Coal Harbour (E207813), Clark Drive (E207818), Port Moody IOCO (E207823) and False Creek East (E207814).

The Vancouver Wharves station appeared to have decreasing concentrations of sediment copper, lead, zinc and mercury between 1993 and 2002. For example, sediment copper in 1993 was measured at

2929 µg/g and in 2002 was measured at 436 µg/g. Sediment zinc in 1993 was 985 µg/g and 353 µg/g in 2002.

Vancouver Wharves 1992, 1993, 1994, 2000 and 2002 sediment chemistry data

	1992	1993	1994	2000	2002
Cadmium (µg/g)	-	**5.0**	**5.0**	**2.5**	**1.9**
Copper (µg/g)	-	**2929**	**1950**	**985**	**436**
Lead (µg/g)	-	**360**	**165**	**126**	**72.5**
Zinc (µg/g)	-	**985**	**1120**	**575**	**353**
Mercury (µg/g)	**0.407**	**0.36**	**-**	**0.181**	0.13

Bold = exceeds Burrard Inlet Objective

The Coal Harbour monitoring station did not have observable trends in sediment copper, lead, mercury and zinc despite relatively lower levels measured here than at Vancouver Wharves. These parameters have exceeded their sediment objectives since 1992 and thus, sediment quality appears to be unchanged at this site. Most species of heavy PAHs exceeded sediment objectives at this site based with a possible downward trend between 1992 and 2002. In addition, sediment PCBs, which have been monitored at this site since 1992 failed to meet the objective. More data is needed to verify whether sediment PCBs are increasing at this site.

Coal Harbour 1992, 1993, 1994, 2000 and 2002 sediment chemistry data

	1992	1993	1994	2000	2002
Cadmium (µg/g)	<1 - 1	<1	**2.0**	**1.3 – 1.6**	0.83
Copper (µg/g)	**201**	**240**	**238**	**108-235**	**155**
Lead (µg/g)	**81**	**98**	**82**	**46-136**	**57.1**
Zinc (µg/g)	**154**	**187**	**181**	**152-237**	137
Mercury (µg/g)	**0.838**	**0.89**	**-**	0.453	0.36
PCBs (µg/g)	<0.02	**0.05**	**0.11**	**0.101**	**0.15**
HPAHs (µg/g)	**6.02**	**4.58**	**-**	**2.11 – 4.91**	**2.1**

Bold = exceeds Burrard Inlet Objective

The Clark Drive monitoring station, similar to the Coal Harbour station, did not have observable trends in sediment copper, lead, mercury and zinc concentrations. These parameters' concentrations were again significantly less than those found at Vancouver Wharves sediments but were in a similar range to the sediment concentrations at Coal Harbour. Both Coal Harbour and Clark Drive monitoring stations are significantly influenced by large combined sewer outfalls.

Clark Drive 1992, 1993, 1994, 2000 and 2002 sediment chemistry data

	1992	1993	1994	2000	2002
Cadmium (µg/g)	**2**	**-**	<1.0	**1.1**	**1.34**
Copper (µg/g)	**375**	**-**	**125**	**199**	**157**
Lead (µg/g)	**198**	**-**	**66**	**168**	**61.1**
Zinc (µg/g)	**318**	**-**	147	**268**	**216**
Mercury (µg/g)	**2.166**	**0.35**	**-**	**1.76**	**1.23**
PCBs (µg/g)	**0.04**	<0.02	<0.02	**0.041**	<0.02

Bold = exceeds Burrard Inlet Objective

The Port Moody at IOCO monitoring station did not meet sediment objectives for copper, lead and zinc from 1993 to 2002. Sediment copper, lead, zinc and HPAH levels, however, appear to be improving over this time period. For example, in 1993, sediment lead concentration was 102µg/g and in 2002 it was 12.8 µg/g. Sediment HPAH concentration in 1992 was 12.21 µg/g while in 2002 it was 0.58µg/g. The IOCO

refinery has changed from being a petroleum refinery facility in 1993 to currently being a bulk petroleum storage facility which may explain these improvements.

Port Moody IOCO 1992, 1993, 1994, 2000 and 2002 sediment chemistry data

	1992	1993	1994	2000	2002
Cadmium (µg/g)	**-**	**2**	**2**	**2.3**	**0.29**
Copper (µg/g)	**-**	**133**	**116**	**132.9**	**45.2**
Lead (µg/g)	**-**	**102**	**77**	**85**	**12.8**
Zinc (µg/g)	**-**	**213**	**189**	**204**	**61.4**
Mercury (µg/g)	**-**	**-**	**-**	**0.219**	**0.62**
PCBs (µg/g)	**-**	<0.02	<0.02	**0.044**	<0.02
HPAHs (µg/g)	**12.21**	**4.471**	**10**	**6.29**	0.58

Bold = exceeds Burrard Inlet Objective

The False Creek East monitoring station has not been included in attainment monitoring to the same degree as the above stations. This monitoring station does not show any observable trends for sediment heavy metals and PCB concentrations in previous years. It is recommended that this station continue to be a priority for future attainment monitoring.

False Creek East 1992, 1993, 1994, 2000 and 2002 sediment chemistry data

	1992	1993	1994	2000	2002
Cadmium (µg/g)	**2.33**	**2.33**	**2**	**1.8**	**-**
Copper (µg/g)	**159**	**144**	**141**	**134**	**-**
Lead (µg/g)	**159**	**152**	**129**	**129**	**-**
Zinc (µg/g)	**367**	**366**	**333**	**332**	**-**
Mercury (µg/g)	**0.620**	**0.62**	**-**	**0.412**	**-**
PCBs (µg/g)	**0.07**	**0.06**	**0.09**	**0.068**	-
HPAHs (µg/g)	**9.27**	**5.74**	**3.2**	**2.04 – 4.92**	-

Bold = exceeds Burrard Inlet Objective

In general, the trends appear to show improving conditions in sediment quality near large industrial permitted discharges such as Vancouver Wharves and IOCO Port Moody while sediment measured near combined sewer/stormwater outfalls (Coal Harbour and Clark Drive) appears to have no observable trends for contaminants of concern.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Water Quality Objectives were not met for:

marine water

- Enterococci at five of eight sites where the objective applies (although samples were collected over 50 days rather than the recommended 30 days).
- Dissolved oxygen at many sites on many dates (22% non-attainment in surface water; 89% non-attainment in deeper water). These conditions seem worse as the values in excess of objectives are more widespread in the inlet than in they were in 1993 and 1994.
- Suspended solids at Shellburn (once).
- Copper in the water column at False Creek West and Coal Harbour (once at each site). This data is similar to 1993 and 1994 when the copper objective was exceeded at times.
- marine water column lead concentrations were historically not always met at some monitoring stations prior to1994, however water column lead objectives were met at all stations in 2000 and 2002

marine sediment

- Cadmium, copper, lead, mercury and zinc in sediments at some sites. Sites in the inner harbour had the greatest number of values in excess sediment quality objectives . Cadmium, copper, lead

and zinc also exceeded sediment objectives in 1993 and 1994. Sediment copper, lead and zinc near Vancouver Wharves and IOCO Port Moody (large industrial permitted discharges) appears to be improving since 1992 while sediment measured near Coal Harbour and Clark Drive (combined sewer/stormwater outfalls) appears to have no observable trends for contaminants of concern.

- PAHs (total high molecular weight as well as individual PAHs) in the inner harbour. Many PAHs also exceeded objectives in 1993 and 1994 in these sub-basins.
- PCBs in sediment at Coal Harbour and Pacific Coast Terminals. PCBs also exceeded the sediment objective at sites in 1993 and 1994.

In general, some water and sediment quality parameters appear to be improving at certain locations while other parameters are staying the same or worsening. There appears to be an improving trend for sediment quality at some stations associated with permitted discharges while some stations influenced by combined sewerage/stormwater outfalls are not experiencing any sediment quality improvements. It is difficult to determine clear improvements, status quo or worsening conditions without a larger and more consistent data base of attainment monitoring. Longer attainment monitoring records for specific sites needs to be established to determine real trends.

Future Water Quality Objectives monitoring in Burrard Inlet should focus on:

- Enterococci in high use recreational areas.
- Dissolved oxygen.
- Sediment sampling and analyses for metals, mercury, PAHs and PCBs (including different congeners).
- Fish tissue sampling including analyses with lower laboratory detection limits for PCBs, mercury and lead.
- any new parameters identified by researchers and approved for inclusion in the objectives such as polybrominated diphenyl ethers (PBDEs) and PCBs sediment objective levels that are protective of higher trophic level organisms.
- regularly sampling in typical higher precipitation periods so that attainment is measured under comparable worst-case conditions.
- Maintaining consistency with the monitoring sites so that trend analysis can be conducted.
- Ensuring that attainment monitoring is conducted at sites influenced by permitted discharges and/or combined sewerage/stormwater outfalls so that clear trends can be determined for these uses.

General Recommendations

- link ambient attainment monitoring with permitted discharge monitoring data such as that conducted by the GVRD at the Lions Gate WWTP.
- update permitted waste discharge compliance information and status as per the *Burrard Inlet Water Quality Objectives Technical Appendix 1990.*
- examine whether clear trends are occurring such as that observed at the CSO-influenced monitoring stations where no or minimal improvements to sediment quality have been observed. Obtain statistically significant data that can be used to indicate long term trends
- Communicate to the appropriate agency and establish an action plan about the objectives that are not met and those objectives that continue to be not met or are worsening.

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APPENDIX A: WATER QUALITY OBJECTIVES ATTAINMENT

VARIABLE & OBJECTIVE	MEASUREMENT				CONCLUSION
	SITE	DATE	n	VALUE	
Fecal Coliforms <200 /100 mL geometric mean (gm) Apr - Oct	0300076 English Bay Centre	Oct 2 - Nov 21	5	1 - 110 CFU / 100 mL gm = 8 CFU / 100 mL	Objective met[1]
	GVRD 101 Third Beach below concession area	Jan 14 - Dec 5	64	20 - 800 MPN/100 mL	
		Apr 4 - Oct 8	10	geomean = 20 - 57 MPN/100 mL	Objective met
Apr - Oct [1] the calculated geometric mean is from five dates in 51 days rather than 30 days	GVRD 200 Second Beach at north end	Jan 14 - Dec 5	64	20 - 5000 MPN/100 mL geomean = 23 - 108 MPN/100 mL	
		Apr 4 - Oct 8	9		Objective met
		Jun 25 - Jul 9	10	geomean = 370 MPN/100 mL	**Objective not met**
	GVRD 304 English Bay Beach at north end of bath house	Jan 14 - Dec 27	65	20 - 2400 MPN/100 mL	
		Apr 4 - Oct 8	10	geomean = 23 - 80 MPN/100 mL	Objective met
	GVRD 703 Locarno Beach at bath house	Jan 16 - Dec 9	61	20 - 800 MPN/100 mL	
		Apr 3 - Oct 15	10	geomean = 20 - 57 MPN/100 mL	Objective met
	E207815 False Creek West End	Oct 2 - Nov 21	5	9 - 780 CFU / 100 mL gm = 56 CFU / 100 mL	Objective met[1]
	E207816 Vancouver Wharves	Oct 2 - Nov 21	5	18 - 230 CFU / 100 mL gm = 96 CFU / 100 mL	Objective met[1]
	E207813 Coal Harbour	Oct 2 - Nov 21	5	17 – 870 CFU / 100 mL gm = 142 CFU / 100 mL	Objective met[1]
	E207818 Clarke Drive	Oct 2 - Nov 21	5	16 - 660 CFU / 100 mL gm = 112 CFU / 100 mL	Objective met[1]
	E207819 Loch Katrine	Oct 2 - Nov 21	5	1 - 330 CFU / 100 mL gm = 32 CFU / 100 mL	Objective met[1]
	E207822 Shellburn	Oct 2 - Nov 14	4	1 - 30 CFU / 100 mL gm = 6 CFU / 100 mL	Indefinite result
	E207823 Port Moody IOCO	Oct 2 - Nov 21	5	2 - 160 CFU / 100 mL gm = 18 CFU / 100 mL	Objective met[1]
	E207698 Pacific Coast Terminal	Oct 2 - Nov 21	5	3 - 180 CFU / 100 mL gm = 23 CFU / 100 mL	Objective met[1]
	0300080 at Cable Crossing	Oct 2 - Nov 21	5	1 - 34 CFU / 100 mL gm = 4 CFU / 100 mL	Objective met[1]

VARIABLE & OBJECTIVE	MEASUREMENT				CONCLUSION
	SITE	DATE	n	VALUE	
Enterococci <20 /100 mL geometric mean (gm) Apr - Oct [1] the calculated geometric mean is from five dates in 51 days rather than 30 days	0300076 English Bay Centre	Oct 2 - Nov 21	5	1 - 55 CFU / 100 mL gm = 5 CFU / 100 mL	Objective met[1]
	E207815 False Creek West End	Oct 2 - Nov 21	5	1- 880 CFU / 100 mL gm = 23 CFU / 100 mL	**Objective not met**
	E207816 Vancouver Wharves	Oct 2 - Nov 21	5	8 - 94 CFU / 100 mL gm = 30 CFU / 100 mL	**Objective not met[1]**
	E207813 Coal Harbour	Oct 2 - Nov 21	5	38 - 290 CFU / 100 mL gm = 104 CFU / 100 mL	**Objective not met[1]**
	E207818 Clarke Drive	Oct 2 - Nov 21	5	4 - 290 CFU / 100 mL gm = 41 CFU / 100 mL	**Objective not met[1]**
	E207819 Loch Katrine	Oct 2 - Nov 21	5	2 - 260 CFU / 100 mL gm = 38 CFU / 100 mL	**Objective not met[1]**
	E207822 Shellburn	Oct 2 - Nov 14	4	1 - 14 CFU / 100 mL gm = 5 CFU / 100 mL	Objective met[1]
	E207823 Port Moody IOCO	Oct 2 - Nov 21	5	1 - 210 CFU / 100 mL gm = 9 CFU / 100 mL	Objective met[1]
	E207698 Pacific Coast Terminal	Oct 2 - Nov 21	5	6 - 190 CFU / 100 mL gm = 24 CFU / 100 mL	**Objective not met[1]**
	Indian Arm 0300080 at Cable Crossing	Oct 2 - Nov 21	5	1 - 18 CFU / 100 mL gm = 3 CFU / 100 mL	Objective met[1]
Suspended Solids 10 mg/L max. increase above background	0300076 English Bay Centre	Oct 2 - Nov 21	5	< 4 - 12 mg/L ave = 8.8 mg/L	Control Site
	E207814 False Creek East End	Oct 2 - Nov 21	5	<4 – 13 mg/L ave = 9.2 mg/L	Objective met
	E207815 False Creek West End	Oct 2 - Nov 21	5	<4 – 11 mg/L ave = 7.4 mg/L	Objective met
	Vancouver Wharves E207816	Oct 2 - Nov 21	10	<4 – 20 mg/L ave = 11.4 mg/L	Objective met
	E207813 Coal Harbour	Oct 2 - Nov 21	4	4 – 11 mg/L ave = 9.0 mg/L	Objective met
	E207818 Clarke Drive	Oct 2 - Nov 21	5	5 – 15 mg/L ave = 9.2 mg/L	Objective met
	E207819 Loch Katrine	Oct 2 - Nov 21	5	<4 – 17 mg/L ave = 9.4 mg/L	Objective met
	E207822 Shellburn	Oct 2 - Nov 21 Oct 16	4 1	<4 – 22 mg/L ave = 11.6 mg/L	**Objective not met once**
	E207823 Port Moody IOCO	Oct 2 - Nov 21	5	<4 – 20 mg/L ave = 9.6 mg/L	Objective met
	E207698 Pacific Coast Terminal	Oct 2 - Nov 21	5	5 – 20 mg/L ave = 9.8 mg/L	Objective met
	Indian Arm: 0300080 at Cable Crossing	Oct 2 - Nov 21	5	<4 – 11 mg/L ave = 7.6 mg/L	Objective met

VARIABLE & OBJECTIVE	MEASUREMENT				CONCLUSION
	SITE	DATE	n	VALUE	
Ammonia-N 2.5 mg/L max.	0300076 English Bay Centre	Oct 2 - Nov 21	5	< 0.005 - 0.02 mg/L av = 0.008 mg/L	Objective met Indefinite result
	E207814 False Creek East End	Oct 2 - Nov 21	5	< 0.005 - 0.098 mg/L av = 0.053 mg/L	Objectives met
	E207815 False Creek West End	Oct 2 - Nov 21	5	< 0.005 - 0.048 mg/L av = 0.021 mg/L	Objectives met
	Vancouver Wharves E207816	Oct 2 - Nov 21	10	< 0.005 - 0.069 mg/L av = 0.014 mg/L	Objectives met
	E207813 Coal Harbour	Oct 2 - Nov 21	6	0.01 - 0.076 mg/L av = 0.046 mg/L	Objectives met
	E207818 Clarke Drive	Oct 2 - Nov 21	5	< 0.005 - 0.017 mg/L av = 0.010 mg/L	Objectives met
	E207819 Loch Katrine	Oct 2 - Nov 21	5	< 0.005 - 0.014 mg/L av = 0.008 mg/L	Objectives met
	E207822 Shellburn	Oct 2 - Nov 21	5	< 0.005 - 0.009 mg/L av = 0.006 mg/L	Objectives met
	E207823 Port Moody IOCO	Oct 2 - Nov 21	5	< 0.005 - 0.042 mg/L av = 0.016 mg/L	Objectives met
	E207698 Pacific Coast Terminal	Oct 2 - Nov 21	5	< 0.005 - 0.055 mg/L av = 0.015 mg/L	Objectives met
	Indian Arm: 0300080 at Cable Crossing	Oct 2 - Nov 21	5	< 0.005 - 0.054 mg/L av = 0.015 mg/L	Objectives met
pH 6.5 - 8.5	E207822 Shellburn	Oct 2 - Nov 21	4	7.5 - 7.7	Objective met
Dissolved Oxygen 6.5 mg/L minimum	English Bay Center 0300076	Oct 2,9,16, Nov 14,21	10	0 m: 7.4 – 8.7 mg/L ave = 8.1 mg/L 8 m: 4.3 – 9.3 mg/L ave = 5.8	Objective met at surface, **not met at depth**
	False Creek East E207814	Oct 2,9,16, Nov 14,21	10	0 m: 6.1 – 8.4 mg/L ave = m7.0 mg/L 5 m: 3.0 – 6.6 mg/L ave = 4.2 mg/L	**Objective not met at surface & depth**
	False Creek West E207815	Oct 2,9,16, Nov 14,21	10	0 m: 6.6 – 8.3 mg/L ave = 7.4 mg/L 4 m: 4.1 – 6.3 mg/L ave = 5.2 mg/L	Objective met at surface, **not met at depth**
	Vancouver Wharves E207816	Oct 2,9,16, Nov 14,21	10	0 m: 5.7 – 7.5 mg/L ave = 6.5 mg/L 5 m: 4.9 – 6.8 mg/L ave = 5.9 mg/L	**Objective not met at surface & depth**
	Coal Harbour E207813	Oct 2,9,16, Nov 14,21	10	0 m: 6.4 – 7.2 mg/L ave = 6.7mg/L 6 m: 4.7 – 6.0 mg/L ave = 4.2 mg/L	**Objective not met at surface & depth**
	Clark Drive E207818	Oct 2,9,16, Nov 14,21	10	0 m: 5.3 – 6.7 mg/L ave = 7.4 mg/L 16 m: 4.9 – 6.4 mg/L ave = 5.5 mg/L	**Objective not met at surface & depth**
	Loch Katrine E207819	Oct 2,9,16, Nov 14,21	10	0 m: 6.4 – 7.5 mg/L ave = 6.7 mg/L 20 m: 5.2 – 6.9 mg/L ave = 5.9 mg/L	**Objective not met at surface & depth**

VARIABLE & OBJECTIVE	MEASUREMENT				CONCLUSION
	SITE	DATE	n	VALUE	
Dissolved Oxygen 6.5 mg/L minimum	Shellburn E207822	Oct 2,9,16, Nov 14,21	10	0 m: 6.1 – 8.4 mg/L ave = 7.7 mg/L 22 m: 5.0 – 6.2 mg/L ave = 5.7 mg/L	**Objective not met at surface & depth**
	Indian Arm at cable crossing 0300080	Oct 2,9,16, Nov 14,21	10	0 m: 8.6 – 13.6 mg/L ave = 10.6 mg/L 20 m: 5.3 – 6.8 mg/L ave = 5.7 mg/L	Objective met at surface, **not met at depth**
	Port Moody Ioco E207823	Oct 2,9,16, Nov 14,21	10	0 m: 6.9 – 13.7 mg/L ave = 9.6 mg/L 5 m: 4.1 – 11.5 mg/L ave = 4.2 mg/L	Objective met at surface, **not met at depth**
	Pacific Coast Terminals E207698	Oct 2,9,16, Nov 14,21	10	0 m: 6.9 -12.6 mg/L ave = 8.8 mg/L 4 m: 4.6 – 6.2 mg/L ave = 5.1 mg/L	Objective met at surface, **not met at depth**
Total As in water 0.010 mg/L max	E207816 Vancouver Wharves	Oct 9 - Nov 21	8	0.0001 - 0.0008 mg/L	Objective met
	E207813 Coal Harbour	Oct 9 - Nov 21	4	0.0001 - 0.0006 mg/L	Objective met
	E207818 Clarke Drive	Oct 9 - Nov 21	3	0.0001 - 0.0005 mg/L	Objective met
	E207819 Loch Katrine	Oct 9 - Nov 21	3	0.0002 - 0.0007 mg/L	Objective met
	E207822 Shellburn	Oct 9 - Nov 21	3	0.0001 - 0.0004 mg/L	Objective met
Total As in sediment <20 ug/g max	0300076 English Bay Centre	Oct 9	1	7.7 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	2	11.3 - 12.1 ug/g	Objective met
	E207813 Coal Harbour	Oct 16	1	10.5 ug/g	Objective met
	E207818 Clarke Drive	Oct 16	1	5.9 ug/g	Objective met
	E207819 Loch Katrine	Nov 14	1	9.5 ug/g	Objective met
	E207822 Shellburn	Nov 21	1	7.7 ug/g	Objective met
	E207823 Port Moody IOCO	Nov 14	1	4.2 ug/g	Objective met
	E207698 Pacific Coast Terminal	Nov 21	1	11 ug/g	Objective met
Total Cd in water <0.009 mg/L av 0.043 mg/L max.	E207816 Vancouver Wharves	Oct 9 - Nov 21	8	< 0.0001 - 0.0001 mg/L av = 0.0001 mg/L	Max Objective met Average Objective met
	E207813 Coal Harbour	Oct 9 - Nov 21	4	< 0.0001 - 0.0001 mg/L av = 0.0001 mg/L	Max Objective met
	E207818 Clarke Drive	Oct 9 - Nov 21	3	< 0.0001 - 0.0001 mg/L av = 0.0001 mg/L	Max Objective met

VARIABLE & OBJECTIVE	MEASUREMENT				CONCLUSION
	SITE	DATE	n	VALUE	
Total Cd in water <0.009 mg/L av 0.043 mg/L max.	E207819 Loch Katrine	Oct 9 - Nov 21	3	< 0.0001 - 0.0001 mg/L av = 0.0001 mg/L	Max Objective met
	E207822 Shellburn	Oct 9 - Nov 21	3	< 0.0001 - 0.0001 mg/L av = 0.0001 mg/L	Max Objective met
	E207823 Port Moody IOCO	Oct 9 - Nov 21	3	< 0.0001 - 0.0001 mg/L av = 0.0001 mg/L	Max Objective met
	E207698 Pacific Coast Terminal	Oct 9 - Nov 21	3	< 0.0001 - 0.0001 mg/L av = 0.0001 mg/L	Max Objective met
	0300080 at Cable Crossing	Oct 9 - Nov 21	3	< 0.0001 - 0.0001 mg/L av = 0.0001 mg/L	Max Objective met Indefinite result
Total Cd in sediment <1.0 ug/g max.	0300076 English Bay Centre	Oct 9	1	0.17 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	2	1.9 - 2.18 ug/g	**Objective not met**
	E207813 Coal Harbour	Oct 16	1	0.83 ug/g	Objective met
	E207818 Clarke Drive	Oct 16	1	1.34 ug/g	**Objective not met**
	E207819 Loch Katrine	Nov 14	1	1.64 ug/g	**Objective not met**
	E207822 Shellburn	Nov 21	1	0.57 ug/g	Objective met
	E207823 Port Moody IOCO	Nov 14	1	0.29 ug/g	Objective met
	E207698 Pacific Coast Terminal	Nov 21	1	1.79 ug/g	**Objective not met**
Total Cd in sediment < 9 ug/g av < 43 ug/g max	Indian Arm: 0300080 at Cable Crossing	Oct 15	1	0.5 mg/L av = 0.5 mg/L	Max Objective met Indefinite result
Total Cr in water <0.050 mg/L max.	E207814 False Creek East End	Oct 9 - Nov 21	6	all < 0.0005 mg/L	Objective met
	E207815 False Creek West End	Oct 9 - Nov 21	3	all < 0.0005 mg/L	Objective met
	E207822 Shellburn	Oct 9 - Nov 21	3	all < 0.0005 mg/L	Objective met
	E207823 Port Moody IOCO	Nov 14	3	all < 0.0005 mg/L	Objective met
	E207698 Pacific Coast Terminal	Nov 21	3	all < 0.0005 mg/L	Objective met

VARIABLE & OBJECTIVE	MEASUREMENT				CONCLUSION
	SITE	DATE	n	VALUE	
Total Cr in sediment < 60 ug/g max.	0300076 English Bay Centre	Oct 9	1	37.3 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	2	31.3 - 34.4 ug/g	Objective met
	E207813 Coal Harbour	Oct 16	1	26.8 ug/g	Objective met
	E207818 Clarke Drive	Oct 16	1	33.4 ug/g	Objective met
	E207819 Loch Katrine	Nov 14	1	41.1 ug/g	Objective met
	E207822 Shellburn	Nov 21	1	19 ug/g	Objective met
	E207823 Port Moody IOCO	Nov 14	1	10.2 ug/g	Objective met
	E207698 Pacific Coast Terminal	Nov 21	1	36.4 ug/g	Objective met
Total Cu in water <0.002 mg/L av 0.003 mg/L max.	0300076 English Bay Centre	Oct 9 - Nov 21	3	0.3 - 0.8 mg/L av = 0.008 mg/L	Objective met Indefinite result
	E207814 False Creek East End	Oct 9 - Nov 21	6	0.0005 - 0.0021 mg/L av = 0.0014 mg/L	Max Objective met Average Objective met
	E207815 False Creek West End	Oct 9 - Nov 21	3	0.0019 - 0.003 mg/L av = 0.0020 mg/L	Max Objective met Indefinite result
	E207816 Vancouver Wharves	Oct 9 - Nov 21	8	0.0004 - 0.0016 mg/L av = 0.00069 mg/L	Max Objective met Average Objective met
	E207813 Coal Harbour	Oct 9 - Nov 14 Nov 21	2 2	0.0001 - 0.0008 mg/L 0.0052 - 0.0054 mg/L av = 0.0029 mg/L	**Max Objective not met** Indefinite result
	E207818 Clarke Drive	Oct 9 - Nov 21	3	0.0004 - 0.0008 mg/L av = 0.0006 mg/L	Max Objective met Indefinite result
	E207819 Loch Katrine	Oct 9 - Nov 21	3	0.0004 - 0.0005 mg/L av = 0.00047 mg/L	Max Objective met Indefinite result
	E207822 Shellburn	Oct 9 - Nov 21	3	0.0002 - 0.0005 mg/L av = 0.00033 mg/L	Max Objective met Indefinite result
	E207823 Port Moody IOCO	Oct 9 - Nov 21	3	0.0006 - 0.0009 mg/L av = 0.00073 mg/L	Max Objective met Indefinite result
	E207698 Pacific Coast Terminal	Oct 9 - Nov 21	3	0.0005 - 0.0012 mg/L av = 0.0010 mg/L	Max Objective met Indefinite result
	Indian Arm: 0300080 at Cable Crossing	Oct 9 - Nov 21	3	0.0001 - 0.0004 mg/L av = 0.00027 mg/L	Max Objective met Indefinite result

VARIABLE & OBJECTIVE	MEASUREMENT				CONCLUSION
	SITE	DATE	n	VALUE	
Total Cu in sediment 100 µg/g dry wt	0300076 English Bay Centre	Oct 9	1	44.1 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	2	436 - 450 ug/g	**Objective not met**
	E207813 Coal Harbour	Oct 16	1	155 ug/g	**Objective not met**
	E207818 Clarke Drive	Oct 16	1	157 ug/g	**Objective not met**
	E207819 Loch Katrine	Nov 14	1	84.2 ug/g	Objective met
	E207822 Shellburn	Nov 21	1	86.5 ug/g	Objective met
	E207823 Port Moody IOCO	Nov 14	1	45.2 ug/g	Objective met
	E207698 Pacific Coast Terminal	Nov 21	1	48.5 ug/g	Objective met
Total Pb in water < 0.002 mg/L av. 0.140 mg/L max.	0300076 English Bay Centre	Oct 9 - Nov 21	3	< 0.0001 - 0.0002 mg/L av = 0.00013 mg/L	Max Objective met Indefinite result
	E207814 False Creek East End	Oct 9 - Nov 21	6	< 0.0001 - 0.0006 mg/L av = 0.0004 mg/L	Max Objective met Average Objective met
	E207815 False Creek West End	Oct 9 - Nov 21	3	< 0.0001 - 0.0004 mg/L av = 0.0002 mg/L	Max Objective met Indefinite result
	E207816 Vancouver Wharves	Oct 9 - Nov 21	8	< 0.0001 - 0.0009 mg/L av = 0.00021 mg/L	Max Objective met Average Objective met
	E207813 Coal Harbour	Oct 9 - Nov 21	4	< 0.0001 - 0.0007 mg/L av = 0.00035 mg/L	Max Objective met Indefinite result
	E207818 Clarke Drive	Oct 9 - Nov 21	3	< 0.0001 - 0.0002 mg/L av = 0.0001 mg/L	Max Objective met Indefinite result
	E207819 Loch Katrine	Oct 9 - Nov 21	3	< 0.0001 - 0.0002 mg/L av = 0.0001 mg/L	Max Objective met Indefinite result
	E207822 Shellburn	Oct 9 - Nov 21	3	0.0001 - 0.0009 mg/L av = 0.00037 mg/L	Max Objective met Indefinite result
	E207823 Port Moody IOCO	Oct 9 - Nov 21	3	0.0001 - 0.0012 mg/L av = 0.0005 mg/L	Max Objective met Indefinite result
	E207698 Pacific Coast Terminal	Oct 9 - Nov 21	3	0.0001 - 0.0013 mg/L av = 0.00057 mg/L	Max Objective met Indefinite result
	Indian Arm: 0300080 at Cable Crossing	Oct 9 - Nov 21	3	0.0001 - 0.0003 mg/L av = 0.00017 mg/L	Max Objective met Indefinite result

VARIABLE & OBJECTIVE	MEASUREMENT				CONCLUSION
	SITE	DATE	n	VALUE	
Total Pb in fish muscle 0.8 µg/g max (wet weight)	0300076 English Bay Centre	Jan 23	1	< 0.1 ug/g	Objective met
	E207816 Vancouver Wharves	Jan 23	1	< 0.1 ug/g	Objective met
	E207813 Coal Harbour	Jan 24	1	< 0.1 ug/g	Objective met
	E207818 Clarke Drive	Jan 24	1	< 0.1 ug/g	Objective met
	E207819 Loch Katrine	Jan 24	1	< 0.1 ug/g	Objective met
	E207822 Shellburn	Jan 23	1	< 0.1 ug/g	Objective met
	E207823 Port Moody IOCO	Jan 23	1	< 0.1 ug/g	Objective met
	E207698 Pacific Coast Terminal	Jan 19	1	< 0.1 ug/g	Objective met
	Indian Arm: 0300080 at Cable Crossing	Jan 22	1	< 0.1 ug/g	Objective met
Total Pb in sediment 30 µg/g dry wt.	0300076 English Bay Centre	Oct 9	1	18.6 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	2	72.5 - 92.3 ug/g	**Objective not met**
	E207813 Coal Harbour	Oct 16	1	57.1 ug/g	**Objective not met**
	E207818 Clarke Drive	Oct 16	1	61.1 ug/g	**Objective not met**
	E207819 Loch Katrine	Nov 14	1	63.7 ug/g	**Objective not met**
	Pt. E207822 Shellburn	Nov 21	1	28.5 ug/g	Objective met
	E207823 Port Moody IOCO	Nov 14	1	12.8 ug/g	Objective met
	E207698 Pacific Coast Terminal	Nov 21	1	69.4 ug/g	Objective not met
Total Hg in fish 0.5 µg/g max. wet weight	E207813 Coal Harbour	Jan 24	1	< 0.05 ug/g	Objective met
	E207818 Clarke Drive	Jan 24	1	< 0.05 ug/g	Objective met
	Pt. E207822 Shellburn	Jan 23	1	0.02 ug/g	Objective met
	Indian Arm: 0300080 at Cable Crossing	Jan 22	1	< 0.05 ug/g	Objective met

VARIABLE & OBJECTIVE	MEASUREMENT				CONCLUSION
	SITE	DATE	n	VALUE	
Total Hg in sediment 0.15 µg/g max. dry weight	0300076 English Bay Centre	Oct 9	1	0.06 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	2	0.13 - 0.14 ug/g	Objective met
	E207813 Coal Harbour	Oct 16	1	0.36 ug/g	**Objective not met**
	E207818 Clarke Drive	Oct 16	1	1.23 ug/g	**Objective not met**
	E207819 Loch Katrine	Nov 14	1	0.18 ug/g	**Objective not met**
	E207822 Shellburn	Nov 21	1	0.11 ug/g	Objective met
	E207823 Port Moody IOCO	Nov 14	1	0.62 ug/g	**Objective not met**
	E207698 Pacific Coast Terminal	Nov 21	1	0.07 ug/g	Objective met
Total Ni in water < 0.008 mg/L av. 0.075 mg/L max.	E207814 False Creek East End	Oct 9 - Nov 21	6	0.0006 - 0.0013 mg/L av = 0.00077 mg/L	Max Objective met Average Objective met
	E207815 False Creek West End	Oct 9 - Nov 21	3	0.0005 - 0.0009 mg/L av = 0.0006 mg/L	Max Objective met Indefinite result
	E207816 Vancouver Wharves	Oct 9 - Nov 21	8	< 0.0005 - 0.0009 mg/L av = 0.00055 mg/L	Max Objective met Average Objective met
	E207813 Coal Harbour	Oct 9 - Nov 21	4	< 0.0005 - 0.0009 mg/L av = 0.00063 mg/L	Max Objective met Indefinite result
	E207818 Clarke Drive	Oct 9 - Nov 21	3	< 0.0005 - 0.002 mg/L av = 0.001 mg/L	Max Objective met Indefinite result
	E207819 Loch Katrine	Oct 9 - Nov 21	3	< 0.0005 - 0.0005 mg/L av = 0.0005 mg/L	Max Objective met Indefinite result
	E207822 Shellburn	Oct 9 - Nov 21	3	< 0.0005 - 0.0005 mg/L av = 0.0005 mg/L	Max Objective met Indefinite result
Total Ni in sediment 45 µg/g dry wt.	0300076 English Bay Centre	Oct 9	1	38.4 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	2	29.5 - 30.1 ug/g	Objective met
	E207813 Coal Harbour	Oct 16	1	23.1 ug/g	Objective met
	E207818 Clarke Drive	Oct 16	1	20.9 ug/g	Objective met
	E207819 Loch Katrine	Nov 14	1	21.8 ug/g	Objective met
	E207822 Shellburn	Nov 21	1	18.3 ug/g	Objective met
	E207823 Port Moody IOCO	Nov 14	1	11.8 ug/g	Objective met
	E207698 Pacific Coast Terminal	Nov 21	1	30.8 ug/g	Objective met

VARIABLE & OBJECTIVE	MEASUREMENT				CONCLUSION
	SITE	DATE	n	VALUE	
Total Zn in water < 0.086 mg/L av. 0.095 mg/L max.	0300076 English Bay Centre	Oct 9 - Nov 21	3	< 0.001 - 0.001 mg/L av = 0.001 mg/L	Max Objective met Indefinite result
	E207814 False Creek East End	Oct 9 - Nov 21	6	0.004 - 0.0013 mg/L av = 0.007 mg/L	Max Objective met Objective met
	E207815 False Creek West End	Oct 9 - Nov 21	3	0.001 - 0.007 mg/L av = 0.003 mg/L	Max Objective met Indefinite result
	E207816 Vancouver Wharves	Oct 9 - Nov 21	8	0.001 - 0.004 mg/L av = 0.002 mg/L	Max Objective met Average Objective met
	E207813 Coal Harbour	Oct 9 - Nov 21	4	0.003 - 0.009 mg/L av = 0.007 mg/L	Max Objective met Indefinite result
	E207818 Clarke Drive	Oct 9 - Nov 21	3	0.001 - 0.003 mg/L av = 0.002 mg/L	Max Objective met Indefinite result
	E207819 Loch Katrine	Oct 9 - Nov 21	3	<0.001 - 0.002 mg/L av = 0.0001 mg/L	Max Objective met Indefinite result
	E207822 Shellburn	Oct 9 - Nov 21	3	< 0.001 - 0.001 mg/L av = 0.001 mg/L	Max Objective met Indefinite result
	E207823 Port Moody IOCO	Oct 9 - Nov 21	3	0.003 - 0.007 mg/L av = 0.0005 mg/L	Max Objective met Indefinite result
	E207698 Pacific Coast Terminal	Oct 9 - Nov 21	3	0.004 - 0.012 mg/L av = 0.004 mg/L	Max Objective met Indefinite result
	Indian Arm: 0300080 at Cable Crossing	Oct 9 - Nov 21	3	all 0.001mg/L av = 0.001 mg/L	Max Objective met Indefinite result
Total Zn in sediment 150 µg/g dry wt.	0300076 English Bay Centre	Oct 9	1	92.4 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	2	353- 398 ug/g	**Objective not met**
	E207813 Coal Harbour	Oct 16	1	137 ug/g	Objective met
	E207818 Clarke Drive	Oct 16	1	216 ug/g	**Objective not met**
	E207819 Loch Katrine	Nov 14	1	165 ug/g	**Objective not met**
	E207822 Shellburn	Nov 21	1	100 ug/g	Objective met
	E207823 Port Moody IOCO	Nov 14	1	61.4 ug/g	Objective met
	E207698 Pacific Coast Terminal	Nov 21	1	119 ug/g	Objective met

VARIABLE & OBJECTIVE	MEASUREMENT				CONCLUSION
	SITE	DATE	n	VALUE	
Chlorophenols	E207816 Vancouver Wharves	Oct 9	1	< 0.225 ug/g	Indefinite result
	E207813 Coal Harbour	Oct 16	1	< 0.45 ug/g	Indefinite result
	E207818 Clarke Drive	Oct 16	1	< 0.45 ug/g	Indefinite result
PCBs < 0.03 ug/g max.	0300076 English Bay Centre	Oct 9	1	< 0.02 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	2	< 0.02 ug/g	Objective met
	E207813 Coal Harbour	Oct 16	1	0.15 ug/g	**Objective not met**
	E207818 Clarke Drive	Oct 16	1	< 0.02 ug/g	Objective met
	E207819 Loch Katrine	Nov 14	1	< 0.02 ug/g	Objective met
	E207822 Shellburn	Nov 21	1	< 0.02 ug/g	Objective met
	E207823 Port Moody IOCO	Nov 14	1	< 0.02 ug/g	Objective met
	E207698 Pacific Coast Terminal	Nov 21	1	0.2 ug/g	**Objective not met**
PCBs < 0.5 µg/g max (wet weight)	0300076 English Bay Centre	Jan 23	1	< 0.2 ug/g	Indefinite result
	E207816 Vancouver Wharves	Jan 23	1	< 0.2 ug/g	Indefinite result
	E207813 Coal Harbour	Jan 24	1	< 0.2 ug/g	Indefinite result
	E207818 Clarke Drive	Jan 24	1	< 0.2 ug/g	Indefinite result
	E207819 Loch Katrine	Jan 24	1	< 0.2 ug/g	Indefinite result
	E207822 Shellburn	Jan 23	1	< 0.2 ug/g	Indefinite result
	E207823 Port Moody IOCO	Jan 23	1	< 0.2 ug/g	Indefinite result
	E207698 Pacific Coast Terminal	Jan 19	1	< 0.2 ug/g	Indefinite result
PAHs Acenaphthene in sediment < 0.05 ug/g max. (dry weight)	0300076 English Bay Centre	Oct 9	1	< 0.01 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	2	< 0.01 - 0.04 ug/g	Objective met
	E207813 Coal Harbour	Oct 16	1	< 0.01 ug/g	Objective met
	E207818 Clarke Drive	Oct 16	1	< 0.01 ug/g	Objective met
	E207819 Loch Katrine	Nov 14	1	< 0.01 ug/g	Objective met
	E207822 Shellburn	Nov 21	1	< 0.01 ug/g	Objective met

VARIABLE & OBJECTIVE	MEASUREMENT				CONCLUSION
	SITE	DATE	n	VALUE	
PAHs acenaphthene in sediment < 0.05 ug/g max. (dry weight)	E207823 Port Moody IOCO	Nov 14	1	< 0.01 ug/g	Objective met
	E207698 Pacific Coast Terminal	Nov 21	1	0.04 ug/g	Objective met
PAHs acenaphthylene in sediment < 0.06 ug/g max. (dry weight)	0300076 English Bay Centre	Oct 9	1	< 0.01 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	2	< 0.01 ug/g	Objective met
	E207813 Coal Harbour	Oct 16	1	0.03 ug/g	Objective met
	E207818 Clarke Drive	Oct 16	1	< 0.01 ug/g	Objective met
	E207819 Loch Katrine	Nov 14	1	0.04 ug/g	Objective met
	E207822 Shellburn	Nov 21	1	< 0.01 ug/g	Objective met
	E207823 Port Moody IOCO	Nov 14	1	0.02 ug/g	Objective met
	E207698 Pacific Coast Terminal	Nov 21	1	< 0.01 ug/g	Objective met
PAHs anthracene in sediment < 0.1 ug/g max. (dry weight)	0300076 English Bay Centre	Oct 9	1	< 0.01 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	1	0.12 ug/g	**Objective not met**
	E207813 Coal Harbour	Oct 16	1	0.07 ug/g	Objective met
	E207818 Clarke Drive	Oct 16	1	0.07 ug/g	Objective met
	E207819 Loch Katrine	Nov 14	1	0.14 ug/g	**Objective not met**
	E207822 Shellburn	Nov 21	1	0.03 ug/g	Objective met
	E207823 Port Moody IOCO	Nov 14	1	0.03 ug/g	Objective met
	E207698 Pacific Coast Terminal	Nov 21	1	0.07 ug/g	Objective met
PAHs benzo(a)anthracene in sediment < 0.13 ug/g max. (dry weight)	0300076 English Bay Centre	Oct 9	1	0.04 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	2	0.17 - 0.24 ug/g	**Objective not met**
	E207813 Coal Harbour	Oct 16	1	0.19 ug/g	**Objective not met**
	E207818 Clarke Drive	Oct 16	1	0.22 ug/g	**Objective not met**
	E207819 Loch Katrine	Nov 14	1	0.20 ug/g	**Objective not met**

VARIABLE & OBJECTIVE	MEASUREMENT				CONCLUSION
	SITE	DATE	n	VALUE	
PAHs benzo(a)anthracene in sediment < 0.13 ug/g max. (dry weight)	E207822 Shellburn	Nov 21	1	0.08 ug/g	Objective met
	E207823 Port Moody IOCO	Nov 14	1	0.05 ug/g	Objective met
	E207698 Pacific Coast Terminal	Nov 21	1	0.16 ug/g	**Objective not met**
PAHs benzo(a)pyrene in sediment < 0.16 ug/g max. (dry weight)	0300076 English Bay Centre	Oct 9	1	0.04 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	2	0.17 ug/g	**Objective not met**
	E207813 Coal Harbour	Oct 16	1	0.21 ug/g	**Objective not met**
	E207818 Clarke Drive	Oct 16	1	0.20 ug/g	**Objective not met**
	E207819 Loch Katrine	Nov 14	1	0.27 ug/g	**Objective not met**
	E207822 Shellburn	Nov 21	1	0.09 ug/g	Objective met
	E207823 Port Moody IOCO	Nov 14	1	0.05 ug/g	Objective met
	E207698 Pacific Coast Terminal	Nov 21	1	0.10 ug/g	Objective met
PAHs benzo-fluoranthenes in sediment < 0.32 ug/g max. (dry weight)	0300076 English Bay Centre	Oct 9	1	< 0.06 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	1	0.37	**Objective not met**
	E207813 Coal Harbour	Oct 16	1	0.45 ug/g	**Objective not met**
	E207818 Clarke Drive	Oct 16	1	0.40 ug/g	**Objective not met**
	E207819 Loch Katrine	Nov 14	1	0.67 ug/g	**Objective not met**
	E207822 Shellburn	Nov 21	1	0.18 ug/g	Objective met
	E207823 Port Moody IOCO	Nov 14	1	0.11 ug/g	Objective met
	E207698 Pacific Coast Terminal	Nov 21	1	0.23 ug/g	Objective met
PAHs benzo(g,h,i)perylene in sediment < 0.07 ug/g max. (dry weight)	0300076 English Bay Centre	Oct 9	1	< 0.02 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	2	0.09 ug/g	**Objective not met**
	E207813 Coal Harbour	Oct 16	1	0.16 ug/g	**Objective not met**
	E207818 Clarke Drive	Oct 16	1	0.17 ug/g	**Objective not met**
	E207819 Loch Katrine	Nov 14	1	0.17 ug/g	**Objective not met**

VARIABLE & OBJECTIVE	MEASUREMENT				CONCLUSION
	SITE	DATE	n	VALUE	
PAHs benzo(g,h,i)perylene in sediment < 0.07 ug/g max. (dry weight)	Pt. E207822 Shellburn	Nov 21	1	0.07 ug/g	Objective met
	E207823 Port Moody IOCO	Nov 14	1	0.03 ug/g	Objective met
	E207698 Pacific Coast Terminal	Nov 21	1	0.07 ug/g	Objective met
PAHs Chrysene in sediment < 0.14 ug/g max. (dry weight)	0300076 English Bay Centre	Oct 9	1	0.04 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	2	0.21 - 0.4 ug/g	**Objective not met**
	E207813 Coal Harbour	Oct 16	1	0.24 ug/g	**Objective not met**
	E207818 Clarke Drive	Oct 16	1	0.33 ug/g	**Objective not met**
	E207819 Loch Katrine	Nov 14	1	0.37 ug/g	**Objective not met**
	E207822 Shellburn	Nov 21	1	0.09 ug/g	Objective met
	E207823 Port Moody IOCO	Nov 14	1	0.06 ug/g	Objective met
	E207698 Pacific Coast Terminal	Nov 21	1	0.22 ug/g	**Objective not met**
PAHs dibenzo(a,h)anthracene in sediment < 0.06 ug/g max. (dry weight)	0300076 English Bay Centre	Oct 9	1	< 0.02 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	2	< 0.02 ug/g	Objective met
	E207813 Coal Harbour	Oct 16	1	< 0.02 ug/g	Objective met
	E207818 Clarke Drive	Oct 16	1	< 0.02 ug/g	Objective met
	E207819 Loch Katrine	Nov 14	1	< 0.02 ug/g	Objective met
	E207822 Shellburn	Nov 21	1	< 0.02 ug/g	Objective met
	E207823 Port Moody IOCO	Nov 14	1	< 0.02 ug/g	Objective met
	E207698 Pacific Coast Terminal	Nov 21	1	< 0.02 ug/g	Objective met
PAHs Fluoranthene in sediment < 0.17 ug/g max. (dry weight)	0300076 English Bay Centre	Oct 9	1	0.06 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	2	0.38 - 0.44 ug/g	**Objective not met**
	E207813 Coal Harbour	Oct 16	1	0.31 ug/g	**Objective not met**
	E207818 Clarke Drive	Oct 16	1	0.52 ug/g	**Objective not met**
	E207819 Loch Katrine	Nov 14	1	0.23 ug/g	**Objective not met**

VARIABLE & OBJECTIVE	MEASUREMENT				CONCLUSION
	SITE	DATE	n	VALUE	
PAHs fluoranthene in sediment < 0.17 ug/g max. (dry weight)	E207822 Shellburn	Nov 21	1	0.14 ug/g	Objective met
	E207823 Port Moody IOCO	Nov 14	1	0.13 ug/g	Objective met
	E207698 Pacific Coast Terminal	Nov 21	1	0.39 ug/g	**Objective not met**
PAHs Fluorine in sediment < 0.05 ug/g max. (dry weight)	0300076 English Bay Centre	Oct 9	1	< 0.01 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	2	0.03 ug/g	Objective met
	E207813 Coal Harbour	Oct 16	1	< 0.01 ug/g	Objective met
	E207818 Clarke Drive	Oct 16	1	0.04 ug/g	Objective met
	E207819 Loch Katrine	Nov 14	1	0.06 ug/g	**Objective not met**
	E207822 Shellburn	Nov 21	1	< 0.01 ug/g	Objective met
	E207823 Port Moody IOCO	Nov 14	1	< 0.01 ug/g	Objective met
	E207698 Pacific Coast Terminal	Nov 21	1	0.07 ug/g	**Objective not met**
PAHs indeno(1,2,3-c,d)pyrene in sediment < 0.06 ug/g max. (dry weight)	0300076 English Bay Centre	Oct 9	1	< 0.02 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	2	0.09 ug/g	**Objective not met**
	E207813 Coal Harbour	Oct 16	1	0.16 ug/g	**Objective not met**
	E207818 Clarke Drive	Oct 16	1	0.15 ug/g	**Objective not met**
	E207819 Loch Katrine	Nov 14	1	0.15 ug/g	**Objective not met**
	E207822 Shellburn	Nov 21	1	0.06 ug/g	Objective met
	E207823 Port Moody IOCO	Nov 14	1	< 0.02 ug/g	Objective met
	E207698 Pacific Coast Terminal	Nov 21	1	< 0.02 ug/g	Objective met
PAHs Naphthalene in sediment < 0.2 ug/g max. (dry weight)	0300076 English Bay Centre	Oct 9	1	< 0.01 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	2	0.04 ug/g	Objective met
	E207813 Coal Harbour	Oct 16	1	0.03 ug/g	Objective met
	E207818 Clarke Drive	Oct 16	1	0.03 ug/g	Objective met
	E207819 Loch Katrine	Nov 14	1	0.05 ug/g	Objective met

VARIABLE & OBJECTIVE	MEASUREMENT				CONCLUSION
	SITE	DATE	n	VALUE	
PAHs Naphthalene in sediment < 0.2 ug/g max. (dry weight)	E207822 Shellburn	Nov 21	1	< 0.01 ug/g	Objective met
	E207823 Port Moody IOCO	Nov 14	1	0.07 ug/g	Objective met
	E207698 Pacific Coast Terminal	Nov 21	1	0.13 ug/g	Objective met
PAHs phenanthrene in sediment < 0.15 ug/g max. (dry weight)	0300076 English Bay Centre	Oct 9	1	0.04 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	2	0.16 - 0.19 ug/g	**Objective not met**
	E207813 Coal Harbour	Oct 16	1	0.16 ug/g	**Objective not met**
	E207818 Clarke Drive	Oct 16	1	0.23 ug/g	**Objective not met**
	E207819 Loch Katrine	Nov 14	1	0.2 ug/g	**Objective not met**
	E207822 Shellburn	Nov 21	1	0.06 ug/g	Objective met
	E207823 Port Moody IOCO	Nov 14	1	0.07 ug/g	Objective met
	E207698 Pacific Coast Terminal	Nov 21	1	0.17 ug/g	**Objective not met**
PAHs pyrene in sediment < 0.26 ug/g max. (dry weight)	0300076 English Bay Centre	Oct 9	1	0.09 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	2	0.52 - 0.57 ug/g	**Objective not met**
	E207813 Coal Harbour	Oct 16	1	0.4 ug/g	**Objective not met**
	E207818 Clarke Drive	Oct 16	1	0.49 ug/g	**Objective not met**
	E207819 Loch Katrine	Nov 14	1	0.76 ug/g	**Objective not met**
	E207822 Shellburn	Nov 21	1	0.25 ug/g	Objective met
	E207823 Port Moody IOCO	Nov 14	1	0.15 ug/g	Objective met
	E207698 Pacific Coast Terminal	Nov 21	1	0.33 ug/g	**Objective not met**
Total LPAH (naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene) in sediment < 0.5 ug/g max. (dry weight)	0300076 English Bay Centre	Oct 9	1	0.04 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	2	0.35 - 0.4 ug/g	Objective met
	E207813 Coal Harbour	Oct 16	1	0.29 ug/g	Objective met
	E207818 Clarke Drive	Oct 16	1	0.37 ug/g	Objective met
	E207819 Loch Katrine	Nov 14	1	0.49 ug/g	Objective met
	E207822 Shellburn	Nov 21	1	0.09 ug/g	Objective met
	E207823 Port Moody IOCO	Nov 14	1	0.19 ug/g	Objective met
	E207698 Pacific Coast Terminal	Nov 21	1	0.48 ug/g	Objective met

VARIABLE & OBJECTIVE	MEASUREMENT				CONCLUSION
	SITE	DATE	n	VALUE	
Total HPAH (fluoranthene pyrnen, benxo(a)anthracene, chrysene, benzo-fluoranthenes, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene dibenzo(a,h)anthracene benzo(g,h,i)perylene) in sediment < 1.2 ug/g max. (dry weight)	0300076 English Bay Centre	Oct 9	1	0.32 ug/g	Objective met
	E207816 Vancouver Wharves	Oct 9	2	2.0 - 2.4 ug/g	**Objective not met**
	E207813 Coal Harbour	Oct 16	1	2.1 ug/g	**Objective not met**
	E207818 Clarke Drive	Oct 16	1	2.5 ug/g	**Objective not met**
	E207819 Loch Katrine	Nov 14	1	2.8 ug/g	**Objective not met**
	E207822 Shellburn	Nov 21	1	0.96 ug/g	Objective met
	E207823 Port Moody IOCO	Nov 14	1	0.58 ug/g	Objective met
	E207698 Pacific Coast Terminal	Nov 21	1	1.5 ug/g	**Objective not met**

APPENDIX B: 2002 BURRARD INLET FIELD AND BACTERIOLOGICAL DATA

Site	Date	Tide	Depth (m)	Water Temperature (*C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Fecal Coliforms (CFU/100 mL)	Enterococci (CFU/100 mL)
English Bay Centre 0300076	02-Oct-02	flood	0	12.84	23.11	8.67	2	<1
			8	12.22	26.43	9.29		
	09-Oct-02	ebb	0	12.58	21.27	8.53	6	2
			16.9	10.7	26.61	5.32		
	16-Oct-02	flood	0	11.44	21.62	8.04	1	<1
			10	9.96	27.48	4.28		
	14-Nov-02	flood	0	9.52	24.2	7.48	29	26
			10	9.78	26.86	5.79		
	21-Nov-02	ebb	0	9.35	22.65	7.82	110	55
			10	9.59	29.31	4.51		
False Creek East E207814	02-Oct-02	flood	0	13.68	19.85	8.37	110	26
			5	12.35	25.88	4.52		
	09-Oct-02	ebb	0	12.91	21.24	7.23	98	34
			7	12.86	22.21	6.62		
	16-Oct-02	flood	0	11.7	21.87	6.95	170	<1
			4.5	10.84	26.46	3.02		
	14-Nov-02	flood	0	9.68	22.56	6.08	680	370
			6	9.88	27.99	3.31		
	21-Nov-02	ebb	0	10.17	19.22	6.37	620	300
			7	9.65	27.45	3.61		
False Creek West E207815	02-Oct-02	flood	0	13.46	19.79	8.33	12	<1
			4	12.61	25.62	6.27		
	09-Oct-02	ebb	0	12.64	20.91	7.75	18	2
			7	12.03	24.54	5.75		
	16-Oct-02	flood	0	11.31	21.96	7.63	9	17
			5	10.42	26.91	4.08		
	14-Nov-02	flood	0	9.41	23.89	6.56	780	880
			6	9.84	27.81	4.15		
	21-Nov-02	ebb	0	9.97	19.65	6.91	360	200
			6	9.63	25.52	5.98		
Vancouver Wharves E2207816	02-Oct-02	flood	0	12.03	25.4	6.83	18 , 4	8, 4
			10	12.02	25.42	6.79		
	09-Oct-02	ebb	0	11.71	24.86	6.1	120, 110	37, 33
			10	11.61	25.21	6.07		
	16-Oct-02	flood	0	11.16	25.63	6.12	82, 71	12, 13
			10	11.11	25.65	6.25		
	14-Nov-02	flood	0	9.23	18.5	7.53	200, 160	94, 88
			10	9.81	26.24	4.85		
	21-Nov-02	ebb	0	9.7	24.39	5.7	230	67
			10	9.71	25.22	5.32		

Site	Date	Tide	Depth (m)	Water Temperature (*C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Fecal Coliforms (CFU/100 mL)	Enterococci (CFU/100 mL)
Coal Harbour E207813	02-Oct-02	flood	0	12.02	23.79	6.99	870	290
			6	11.81	25.9	5.85		
	09-Oct-02	ebb	0	11.97	24.23	6.37	120	79
			7	11.72	25.29	5.77		
	16-Oct-02	flood	0	11.62	24.61	6.58	17	38
			6.5	11.07	25.72	5.99		
	14-Nov-02	flood	0	9.21	18.88	7.17	370	170
			7	9.85	25.82	5.06		
	21-Nov-02	ebb	0	9.63	18.03	6.55	89, 130	84, 89
			8	9.66	27.3	4.69		
Clark Drive E207818	02-Oct-02	flood	0	12.13	25.39	6.7	16	4
			16.5	11.94	25.67	6.39		
	09-Oct-02	ebb	0	11.7	24.56	6.24	120	45
			10	11.5	25	6.1		
	16-Oct-02	flood	0	11.25	25.33	6.12	26	18
			10	10.59	26.31	5.07		
	14-Nov-02	flood	0	9.62	23.25	6.43	660	290
			10	9.84	27.36	4.87		
	21-Nov-02	ebb	0	9.78	25.19	5.34	540	130
			10	9.68	26.36	5.18		
Loch Katrine E207819	02-Oct-02	flood	0	12.08	25.13	7.52	6	2
			20	11.95	25.52	6.86		
	09-Oct-02	ebb	0	11.67	24.42	6.46	63	260
			10	11.58	24.82	6.5		
	16-Oct-02	flood	0	11.64	25.56	6.68	1	5
			10	10.94	25.23	5.85		
	14-Nov-02	flood	0	9.51	20.72	6.64	330	140
			10	9.85	26.62	5.2		
	21-Nov-02	ebb	0	9.63	21.09	6.4	250	230
			10	9.67	26.32	5.18		
Shellburn E207822	02-Oct-02	flood	0	12.5	24.44	7.58	2	4
			22	12.24	25.08	6.18		
	09-Oct-02	ebb	0	12	25.09	6.1	23	13
			10	11.02	25.18	6.15		
	16-Oct-02	flood	0	12.1	24.91	8.01	<1	<1
			10	11.61	25.32	5.83		
	14-Nov-02	flood	0	9.37	12.12	8.41	30	14
			10	10.04	26.06	5.04		
	21-Nov-02	ebb	0	9.31	10.59	8.35		
			10	9.87	25.18	5.33		

Site	Date	Tide	Depth (m)	Water Temperature (*C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	Fecal Coliforms (CFU/100 mL)	Enterococci (CFU/100 mL)
Indian Arm @ Cable Crossing 0300080	02-Oct-02	flood	0 ?	12.99 12.46	22.95 24.54	11.28 6.76	<1	<1
	09-Oct-02	ebb	0 10	12.69 12.04	22.97 24.87	10.34 5.38	2	8
	16-Oct-02	flood	0 10	12.43 11.97	23.33 25.06	13.56 5.56	<1	<1
	14-Nov-02	flood	0 10	9.32 10.11	9.5 26.15	8.55 5.31	34	18
	21-Nov-02	ebb	0 10	9.19 9.93	6.81 25.41	9.24 5.34	14	2
Port Moody IOCO E207823	02-Oct-02	flood	0 ?	13.9 12.51	23.84 24.96	10.85 4.52	6	<1
	09-Oct-02	ebb	0 9	12.82 12.33	24.31 25.11	6.85 4.9	13	5
	16-Oct-02	flood	0 9.5	13 12.28	24.35 25	13.67 11.5	2	<1
	14-Nov-02	flood	0 10	9.8 10.36	15.9 26.67	7.41 4.24	82	68
	21-Nov-02	ebb	0 10	9.82 10.19	5.32 25.48	9.26 4.13	160	210
Pacific Coast Terminals E207698	02-Oct-02	flood	0 16	14.07 12.52	23.81 24.96	8.82 5.27	14	12
	09-Oct-02	ebb	0 10	13.06 12.32	24.63 25.13	6.85 4.93	17	10
	16-Oct-02	flood	0 10	13.7 11.94	24.54 25.13	12.57 6.18	3	6
	14-Nov-02	flood	0 10	10.04 10.39	19.05 26.55	7.1 4.56	50	60
	21-Nov-02	ebb	0 10	10.24 10.01	6.99 25.19	8.66 4.62	180	190

APPENDIX C: RAW WATER QUALITY DATA FROM 2002 BURRARD INLET SAMPLING

Site	Date	Depth (m)	Ammonia-N (mg/L)	Suspended Solids (mg/L)	pH	Arsenic (µg/L)	Cadmium (µg/L)	Chromium (µg/L)	Cobalt (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Manganese (µg/L)	Nickel (µg/L)	Zinc (µg/L)
English Bay Centre 0300076	Oct 02		<0.005	11											
	Oct 09		<0.005	12		0.3	0.1	<0.5	<0.1	0.5	17	<0.1	4	<0.5	<1
	Oct 16		<0.005	10											
	Nov 14		0.006	7		0.3	<0.1	<0.5	<0.1	0.8	16	<0.1	5	<0.5	<1
	Nov 21		0.02	<4		0.5	0.1	<0.5	<0.1	0.3	15	0.2	5	0.5	1
False Creek East E207814	Oct 02		0.072	13											
	Oct 09	0	0.042	11		0.2	0.1	<0.5	<0.1	1.9	18	<0.1	6	0.6	4
		8	0.06			0.1	0.1	<0.5	<0.1	1.5	42	0.3	5	0.6	7
	Oct 16		0.046	9											
	Nov 14		<0.005	9		0.3	0.1	<0.5	<0.1	2.1	69	0.6	5	0.8	13
		6				0.2	<0.1	<0.5	<0.1	0.5	57	0.4	4	0.6	7
	Nov 21		0.098	<4		0.7	0.1	<0.5	<0.1	1.8	170	0.6	23	1.3	8
		6				0.7	0.1	<0.5	0.1	0.7	80	0.4	707	0.7	4
False Creek West E207815	Oct 02		0.021	11											
	Oct 09		<0.005	9		0.1	0.1	<0.5	<0.1	1	18	<0.1	43	0.5	2
	Oct 16		0.026	9											
	Nov 14		<0.005	<4		0.7	0.1	<0.5	<0.1	3	1	0.1	1	0.5	1
	Nov 21		0.048	<4		0.7	0.1	<0.5	<0.1	1.9	82	0.4	13	0.9	7
Van Wharves E207816	Oct 02		0.011, 0.069	16, 17											
	Oct 09	0	<0.005, <0.005	13, 13		0.2, 0.1	0.1, 0.1	<0.5, <0.5	<0.1, <0.1	0.6, 0.6	12, 14	<0.1, <0.1	2, 3	0.5, <0.5	1, 4
		10	<0.005			0.1	0.1	<0.5	<0.1	0.7	45	0.2	3	<0.5	3
	Oct 16		0.005, <0.005	20, 10											
	Nov 14		<0.005, <0.005	4, 6		0.2, 0.2	<0.1, <0.1	<0.5, <0.5	<0.1, <0.1	0.5, 0.6	33, 35	<0.1, 0.1	5, 4	<0.5, <0.5	1, 2
		9				0.2	0.1	<0.5	<0.1	0.6	17	0.1	3	<0.5	1
	Nov 21		0.015	<4		0.6	0.1	<0.5	<0.1	0.4	17	0.1	4	0.5	1
		10				0.8	0.1	<0.5	<0.1	1.6	94	0.9	4	0.9	4

Site	Date	Depth (m)	Ammonia-N (mg/L)	Suspended Solids (mg/L)	pH	Arsenic (µg/L)	Cadmium (µg/L)	Chromium (µg/L)	Cobalt (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Manganese (µg/L)	Nickel (µg/L)	Zinc (µg/L)
Coal Harbour E207813	Oct 02		0.075	11											
	Oct 09		0.01	11		0.1	0.1	<0.5	<0.1	0.8	11	<0.1	2	<0.5	3
	Oct 16		0.035	10											
	Nov 14		0.027			0.4	<0.1	<0.5	<0.1	<0.1	42	0.2	9	<0.5	8
	Nov 21		0.076, 0.051	4, 7		0.6, 0.5	0.1, 0.1	<0.5, <0.5	<0.1, <0.1	5.4, 5.2	42, 76	0.4, 0.7	11, 15	0.6, 0.9	9, 9
Clark Drive E207818	Oct 02		0.016	9											
	Oct 09		0.008	15		0.1	0.1	<0.5	<0.1	0.4	17	<0.1	3	<0.5	1
	Oct 16		<0.005	11											
	Nov 14		<0.005	5		0.4	<0.1	<0.5	<0.1	0.8	19	<0.1	4	<0.5	2
	Nov 21		0.017	6		0.5	0.1	<0.5	<0.1	0.6	120	0.2	11	2	3
Loch Katrine E207819	Oct 02		0.014	17											
	Oct 09		<0.005	6		0.2	0.1	<0.5	<0.1	0.5	24	<0.1	2	0.5	1
	Oct 16		<0.005	12											
	Nov 14		<0.005	<4		0.7	<0.1	<0.5	<0.1	0.5	25	<0.1	4	<0.5	2
	Nov 21		0.009	8		0.4	0.1	<0.5	<0.1	0.4	18	0.2	5	<0.5	<1
Shelburn E207822	Oct 02		0.009	15	7.7										
	Oct 09		<0.005	13	7.7	0.2	0.1	<0.5	<0.1	0.5	18	<0.1	2	0.5	1
	Oct 16		<0.005	22											
	Nov 14		<0.005	<4	7.5	0.4	<0.1	<0.5	<0.1	0.3	34	0.1	4	<0.5	<1
	Nov 21		<0.005	<4	7.5	0.1	<0.1	<0.5	<0.1	0.2	13	0.9	3	0.5	1
Indian Arm @ Cable Crossing 0300080	Oct 02		0.054	10	7.9										
	Oct 09		<0.005	11	7.9	0.5	0.1	<0.5	<0.1	0.4	<1	<0.1	1	<0.5	1
	Oct 16		<0.005	9											
	Nov 14		<0.005	<4		0.2	<0.1	<0.5	<0.1	0.3	33	0.1	4	<0.5	1
	Nov 21		<0.005	<4	7.3	0.1	<0.1	<0.5	<0.1	0.1	8	0.3	3	<0.5	1
Port Moody IOCO E207823	Oct 02		0.042	20											
	Oct 09		0.022	11		0.2	0.1	<0.5	<0.1	0.7	18	<0.1	5	0.6	4
	Oct 16		<0.005	8											
	Nov 14		<0.005	5		0.2	<0.1	<0.5	<0.1	0.6	48	0.2	6	0.5	3
	Nov 21		<0.005	<4		0.2	0.1	<0.5	0.1	0.9	220	1.2	2	0.8	7

Site	Date	Depth (m)	Ammonia-N (mg/L)	Suspended Solids (mg/L)	pH	Arsenic (µg/L)	Cadmium (µg/L)	Chromium (µg/L)	Cobalt (µg/L)	Copper (µg/L)	Iron (µg/L)	Lead (µg/L)	Manganese (µg/L)	Nickel (µg/L)	Zinc (µg/L)
Pacific Coast Terminal E207698	Oct 02		0.055	20											
	Oct 09		0.005	12		0.1	0.1	<0.5	<0.1	0.5	20	<0.1	6	0.6	4
	Oct 16		<0.005	7											
	Nov 14		<0.005	5		0.6	<0.1	<0.5	0.1	1.2	150	0.3	14	0.6	12
	Nov 21		<0.005	5		0.3	0.1	<0.5	0.1	1.2	240	1.3	26	0.9	8

APPENDIX D: 2002 BURRARD INLET SEDIMENT QUALITY DATA

Variable	*Objective*	English Bay Centre 300076	Vancouver Wharves **E207816**	Coal Harbour E207813	Clarke Drive E207818	Loch Katrine E207819	Shellburn E207822	Indian Arm @ Cable Crossing 300080	Port Moody IOCO E207823	Pacific Coast Terminal E207698
Physical (% w/w)										
Moisture		47.7	59.5, 58.2	62.8	61	70.1	52.9	62.1	36.3	68.3
Gravel 2.0 mm		3.7	2.7, 4.2	0.6	2.1	0.9	6.8	0.6	0.2	0.2
Coarse Sand 0.59 mm		33.2	22.6, 23.2	3.6	5.3	14.3	18.7	22.8	2.6	12.9
Medium Sand 0.297 mm		13.2	14.1, 14	7.4	11.7	20.5	9.4	13.8	5.1	19.9
Fine Sand 0.149 mm		9.5	16.9, 15.9	9.6	27.4	17.6	14.7	10.7	43	18.9
Very Fine Sand 0.053 mm		13.1	24.1, 22.7	25.5	31.5	16.4	33.2	21.3	43.4	17.6
Silt 0.037 mm		9.8	5.7, 5.8	13.9	5.8	16.8	5.9	12	1.5	16.4
Clay <0.037 mm		17.6	13.9, 14.1	39.3	16.3	13.5	11.3	18.8	4.2	14.3
Carbon (µg/g)										
Total Inorganic Carbon		570	1100, 760	770	770	<500	960	<500	<500	580
Total Organic Carbon		10000	27000, 28000	39000	42000	36000	16000	25000	6900	33000
Total Carbon		11000	28000, 29000	40000	43000	36000	17000	25000	6900	34000
Total Phosphorus (µg/g)		866	929, 912	834	772	668	810	704	451	1040
Metals (µg/g dry weight)										
Aluminum		17200	16300, 16800	11800	9230	15900	11900	11900	10400	18800
Antimony		0.5	1.5, 1.6	1.4	1.4	0.5	0.5	0.5	0.3	3
Arsenic	*20 µg/g*	7.7	12.1, 11.3	10.5	5.9	9.5	7.7	7.3 (n/a)	4.2	11
Barium		47.6	50.3, 50.4	51	40.7	74.6	35.2	38.6	36.2	41.9
Beryllium		0.4	0.2, 0.2	0.3	0.2	0.2	0.2	0.3	0.1	0.4
Bismuth		0.2	0.7, 0.4	0.4	0.5	0.4	0.3	0.3	<0.1	0.3
Cadmium	*1 µg/g*	0.17	**1.9, 2.18**	0.83	**1.34**	**1.64**	0.57	0.5 (n/a)	0.29	**1.79**
Calcium		7450	9130, 9760	6680	15000	8650	7660	6730	5050	6770
Chromium	*60 µg/g*	37.3	31.3, 34.1	26.8	33.4	41.1	19	23	10.2	36.4
Cobalt		12.1	9.5, 9.5	7.8	6.7	6.6	6.8	7.2	5.5	9.3
Copper	*100 µg/g*	44.1	**436, 450**	**155**	**157**	84.2	86.5	**102**	45.2	48.5

Variable	*Objective*	English Bay Centre 300076	Vancouver Wharves **E207816**	Coal Harbour E207813	Clarke Drive E207818	Loch Katrine E207819	Shellburn E207822	Indian Arm @ Cable Crossing 300080	Port Moody IOCO E207823	Pacific Coast Terminal E207698
Iron		32900	30400, 31100	23800	18200	26400	22000	21300	18000	31500
Lead	*30 µg/g*	18.6	**72.5, 92.3**	**57.1**	**61.1**	**63.7**	28.5	**32.9**	12.8	**69.4**
Magnesium		12800	11000, 11000	9520	8490	10300	8050	9630	5820	12500
Manganese		326	270, 275	224	175	224	207	216	193	305
Mercury	*0.15 µg/g*	0.06	0.13, 0.14	**0.36**	**1.23**	**0.18**	0.11	**0.15**	**0.62**	0.07
Molybdenum		1	4.6, 4.5	1.5	14.9	3	1.8	1.4	0.8	6
Nickel	*45 µg/g*	38.4	30.1, 29.5	23.1	20.9	21.8	18.3	20.6	11.8	30.8
Potassium		1600	1670, 1700	1350	1100	2100	1180	1410	1040	2220
Selenium		<0.5	0.7, 0.8	<0.5	<0.5	0.9	<0.5	0.6	<0.5	0.9
Silver		0.37	0.89, 1.2	0.84	3.87	0.43	0.47	0.7	0.29	0.76
Sodium		9700	14800, 14000	14100	13600	17700	9390	14700	4350	19400
Strontium		45.1	58.4, 59.5	49.2	66.7	61.4	52.9	48.1	35.9	56.6
Tellurium		<0.1	<0.1, <0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
Thallium		0.11	0.24, 0.26	0.21	0.31	0.3	0.14	0.15	0.14	0.24
Tin		1.1	2.3, 2.2	5.7	5	2.3	1.4	1.8	0.6	1.2
Titanium		786	778, 767	389	306	652	491	384	652	670
Vanadium		55	54, 55	36	35	45	43	35	40	53
Zinc	*150 µg/g*	92.4	**353, 398**	137	**216**	**165**	100	103	61.4	119
Zirconium		4.6	5, 4.3	1.3	1.9	2.6	2.2	1	1.6	4.7
PCB's (µg/g)										
Total PCB's	*0.03 µg/g*	<0.02	<0.02, <0.02	**0.15**	<0.02	<0.02	<0.02	<0.02	<0.02	**0.2**
Hydrocarbons (µg/g)										
EPHs C10-19		<10	50							
LEPHs		<10	50							
EPHs C19-32		62	290							
HEPHs		62	290							

Variable	*Objective*	English Bay Centre 300076	Vancouver Wharves E207816	Coal Harbour E207813	Clarke Drive E207818	Loch Katrine E207819	Shellburn E207822	Indian Arm @ Cable Crossing 300080	Port Moody IOCO E207823	Pacific Coast Terminal E207698
PAHs (µg/g)										
Acenaphthene	*0.05 µg/g*	<0.01	<0.01, 0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04
Acenapthylene	*0.06 µg/g*	<0.01	<0.01, <0.01	0.03	<0.01	0.04	<0.01	<0.01	0.02	<0.01
Anthracene	*0.1 µg/g*	<0.01	**0.12, 0.1**	0.07	0.07	**0.14**	0.03	0.03	0.03	0.07
Benzo(a)anthracene	*0.13 µg/g*	0.04	**0.24, 0.17**	**0.19**	**0.22**	**0.2**	0.08	0.09	0.05	**0.16**
Benzo(b)fluoranthene		0.05	0.26, 0.28	0.34	0.3	0.52	0.11	0.15	0.08	0.14
Benzo(k)fluoranthene		<0.01	0.1, 0.09	0.11	0.1	0.15	0.07	0.05	0.03	0.09
Benzo(g,h,i)perylene	*0.07 µg/g*	<0.02	**0.09, 0.09**	**0.16**	**0.17**	**0.17**	**0.07**	**0.09**	0.03	**0.07**
Benzo(a)pyrene	*0.16 µg/g*	0.04	**0.17, 0.17**	**0.21**	**0.2**	**0.27**	0.09	0.1	0.05	0.1
Chrysene	*0.14 µg/g*	0.04	**0.4, 0.21**	**0.24**	**0.33**	**0.37**	0.09	0.11	0.06	**0.22**
Dibenz(a,h)anthracene	*0.06 µg/g*	<0.02	<0.02, <0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Fluoranthene	*0.17 µg/g*	0.06	**0.44, 0.38**	**0.31**	**0.52**	**0.23**	0.14	0.16	0.13	**0.39**
Fluorene	*0.05 µg/g*	<0.01	0.03, 0.03	<0.01	0.04	**0.06**	<0.01	<0.01	<0.01	**0.07**
Indeno(1,2,3-c,d)pyrene	*0.06 µg/g*	<0.02	**0.09, 0.09**	**0.16**	**0.15**	**0.15**	**0.06**	**0.08**	<0.02	<0.02
Naphthalene	*0.2 µg/g*	<0.01	0.04, 0.04	0.03	0.03	0.05	<0.01	<0.01	0.07	0.13
Phenanthrene	*0.15 µg/g*	0.04	**0.16, 0.19**	**0.16**	**0.23**	**0.2**	0.06	0.1	0.07	**0.17**
Pyrene	*0.26 µg/g*	0.09	**0.57, 0.52**	**0.4**	**0.49**	**0.76**	0.25	0.19	0.15	**0.33**
Total PAH's		0.36	2.7, 2.4	2.4	2.8	3.3	1	1.1	0.77	2
Total Low MW PAH's	*0.5 µg/g*	0.04	0.35, 0.4	0.29	0.37	0.49	0.09	0.13	0.19	0.48
Total High MW PAH's	*1.2 µg/g*	0.32	2.4, 2	2.1	2.5	2.8	0.96	1	0.58	1.5

Variable	*Objective*	English Bay Centre 300076	Vancouver Wharves E207816	Coal Harbour E207813	Clarke Drive E207818	Loch Katrine E207819	Shellburn E207822	Indian Arm @ Cable Crossing 300080	Port Moody IOCO E207823	Pacific Coast Terminal E207698
Chlorinated phenols (µg/g)	***0.01 µg/g***									
2-chlorophenol			<0.25	<0.5	<0.5			<0.5		
3-chlorophenol			<0.25	<0.5	<0.5			<0.5		
4-chlorophenol			<0.25	<0.5	<0.5			<0.5		
2,3-Dichlorophenol			<0.025	<0.05	<0.05			<0.05		
2,4+3,4-DiClPhenol			<0.025	<0.05	<0.05			<0.05		
2,5-Dichlorophenol			<0.025	<0.05	<0.05			<0.05		
2,6-Dichlorophenol			<0.025	<0.05	<0.05			<0.05		
3,5-Dichlorophenol			<0.025	<0.05	<0.05			<0.05		
2,3,4-Trichlorophenol			<0.025	<0.05	<0.05			<0.05		
2,3,5-Trichlorophenol			<0.025	<0.05	<0.05			<0.05		
2,3,6-Trichlorophenol			<0.025	<0.05	<0.05			<0.05		
2,4,5-Trichlorophenol			<0.025	<0.05	<0.05			<0.05		
2,4,6-Trichlorophenol			<0.025	<0.05	<0.05			<0.05		
3,4,5-Trichlorophenol			<0.025	<0.05	<0.05			<0.05		
2,3,4,5-Trichlorophenol			<0.025	<0.05	<0.05			<0.05		
2346+2356-TeClPhenol			<0.025	<0.05	<0.05			<0.05		
Pentachlorophenol			<0.025	<0.05	<0.05			<0.05		

APPENDIX E: BURRARD INLET FISH TISSUE DATA

	Detection Limit	English Bay Centre 300076	Van Wharves E207816	Coal Harbour E207813	Clarke Drive E207818	Loch Katrine E207819	Shellburn E207822	Ind Arm @ Cable Xing 300080	Port Moody IOCO E207823	Pac Coast Terminal E207698
Moisture (% W/W)	0.1	80.1	79.9	78.3	83.8	82.1	81.5	81.5	78.9	80.4
Lipid Content (%)	0.01	0.44	0.73	0.62	0.56	0.49	0.57	0.62	1.1	0.54
Phosphorus Total (µg/g)	10	3120	2590	2660	2600	2830	2830	2540	2980	3010
Metals (µg/g)										
Aluminum	100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Antimony	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	0.2	1.7	18.7	2.6	10.2	6.5	3	6.7	1.3	1.9
Barium	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beryllium	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Bismuth	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Calcium	100	654	108	439	<100	451	338	282	133	299
Chromium	0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cobalt	0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Copper	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Iron	100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Lead	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Magnesium	100	321	246	321	213	259	247	226	314	272
Manganese	0.2	0.7	<0.2	<0.2	<0.2	0.2	<0.2	<0.2	<0.2	<0.2
Mercury				<0.05	<0.05		0.02	<0.05		
Molybdenum	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	0.8	<0.8	1.5	<0.8	<0.8	<0.8	<0.8	<0.08	<0.8	<0.8
Potassium	100	3360	3230	3030	2790	2840	3230	2750	3520	3490
Selenium	0.5	0.6	0.7	0.5	0.7	<0.5	<0.5	<0.5	<0.5	<0.5
Silver	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Sodium	100	821	561	830	892	1130	972	691	554	711

	Detection Limit	**English Bay Centre** 300076	**Van Wharves** E207816	**Coal Harbour** E207813	**Clarke Drive** E207818	**Loch Katrine** E207819	**Shellburn** E207822	**Ind Arm @ Cable Xing** 300080	**Port Moody IOCO** E207823	**Pac Coast Terminal** E207698
Strontium	0.1	2.1	0.2	1.3	0.3	2	1.1	1.3	0.2	0.7
Tellurium	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Thallium	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Tin	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Titanium	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Vanadium	2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Zinc	0.5	6	3.7	4.8	4.4	6.3	4.9	3.4	4	3.5
Zirconium	0.5	<0.5	<0.5			<0.5			<0.5	<0.5
PCB's (µg/g)										
Total PCB's	0.1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2